ACTA ODONTOLOGICA SCANDINAVICA
VOLUME IX, SUPPLEMENTUM 8

# A CLINICAL STUDY
OF
# THE PERIODONTAL TISSUES OF THE UPPER INCISORS
IN TWO AGE GROUPS

BY
ARNE FORSBERG

1951

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# Preface

The purpose of this investigation was to analyse those periodontal changes associated with age which were clinically demonstrable, and to determine as far as was possible which local factors have an injurious effect on the periodontal tissues. Two age groups were examined. The number of subjects in the younger group was 101, with a median of 24.3 years, and in the older group 102 with a median of 72.0 years.

In the planning and realisation of this work Professor *Gunnar Dahlberg,* Head of the Swedish State Institute of Race Biology, has given invaluable help. He has, furthermore, conducted the statistical treatment of the material which was performed at his Institution. For this and for his indefatigable kindness I am deeply indebted.

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Stockholm, 1st March, 1951

*Arne Forsberg*

# CHAPTER I

## Survey of the literature

### The continuous eruption of the tooth

The first to point out that the eruption of the tooth was not complete at the moment the dental crown made contact with the antagonistic tooth was *Hunter* (1780). It was *Gottlieb* (1921) and his collaborators, however, who were chiefly responsible for putting forward this theory in more modern times.

From the work of *Gottlieb, Orban* and *Diamond* (1938) the following résumé will give the essence of the theories. The eruption into the oral cavity does not terminate on contact of the tooth with its antagonist but continues throughout the whole life although at a greatly reduced rate. This "continuous eruption" is due to the fact that the base of the sulcus is constantly moving in the apical direction. In this respect the authors hold that the following two components are of significance.

1. *Active tooth eruption.* This means the movement of the tooth in the occlusal direction. The base of the sulcus does not alter its position in space but only with respect to the tooth. The base of the alveolus is gradually filled out with other tissue.

2. *Passive tooth eruption.* The base of the sulcus moves "actively" further up towards the apex of the tooth while there is no movement of the tooth itself.

The role played by either of these factors in any particular case is often impossible to decide. The result generally appears the same to the observer in both cases.

When reference is made below to continuous eruption, it is not only the movement of the gingival pocket along the tooth that is meant but

also the alteration of the position of the tooth (the enamel margin) in relation to the alveolar crest and the free gingival margin.

The theory of continuous eruption has been much discussed in the literature. A number of authors seem to accept it, at least to a certain extent, (e. g. *Neuwirt,* 1928; *Coolidge,* 1931; *Kronfeld,* 1933; *Thoma,* 1944; *Merritt,* 1945; *Reichborn-Kjennerud,* 1948; and *Harndt,* 1950).

Other factors than purely physiological ones, however, are able to bring about an increased exposure of the tooth; for example, inflammation of the periodontium or some its tissues (*Häupl & Lang,* 1927, et allii), mechanical trauma (*Gottlieb & Orban,* 1933, et allii) and abnormally attached frenulum labii (*Norberg,* 1941).

The opponents of the theory do not in general deny the possibility of a "secondary eruption" (after occlusal contact with the antagonistic teeth) but they dispute its physiological nature. It is thought that pathological conditions constitute the impelling force (e. g. *Gross,* 1930). The greatly varying rate of continuous eruption from one person to another speaks in favour of this (*Kronfeld,* 1933, and *Riffle,* 1950).

That the rate of secondary eruption can vary among teeth in the same mouth is quite another thing. This was pointed out by *Gottlieb* as early as 1923. The nearer a tooth is to the temporo-mandibular joint the slower the eruption should be if the person is not to have open bite.

Various reasons have been put forward in favour of the theory of continuous eruption. It has been observed in animals, bats and hedgehogs (*Kronfeld & Ullik,* 1928). *Orban* (1926) showed that the epithelial rests which are formed from the Hertwig's root sheath and so lie in the neighbourhood of the root, are apparently moved on the occlusal displacement of the tooth and can sometimes be found in the vascular and nerve channels in the bone a considerable distance from the tip of the root. *Kronfeld* (1936) has shown, with histological preparations of a particular tooth from subjects of different ages, that the exposure of the tooth surface is more pronounced with increase in age.

One way of demonstrating the active phase of continuous eruption would of course be to fix a tooth in the jaw by some means and establish whether it was apparently shortened when the neighbouring teeth moved. Observations of this kind are to be found in the literature.

*Gottlieb* (1924) showed how a lateral upper incisor, which was fixed

by a retained canine tooth clearly showed apparent shortening. How the tooth was fixed in this case is, however, not made clear by the author.

*Sicher* (1928) has given an account of a case where a medial upper incisor displayed apparent shortening after root treatment. It was shown histologically that there occured cavitous resorptions from the root surface and that some of these were filled with newly-formed bone so that the tooth was fixed in its position.

*Kotányi* (1930) replanted the accidentally dislocated 1+ and 2+ of a fourteen-year old boy. A growing merging together of the alveolar bone and the replanted teeth was shown on x-ray film. An apparent shortening in relation to the neighbouring teeth was to be noticed here also.

A number of measurements have been taken on teeth of different age groups in order to detect any contingent secondary eruption.

*Blumentritt* (1926) measured with dividers the distance from the vestibular gingival margin to the highest point occlusally (the visible crown). On 160 teeth from subjects of 20—30 years of age he obtained an average value of 8.6 mm, and on 25 teeth of subjects of 60—82 years an average of 9.18 mm. Thus, in spite of wear the visible crown of the tooth is longer in the case of the older persons.

*Meyer* (1936) examined histological preparations from 40 subjects of the ages 23—86 and obtained results which supported the phenomenon of continuous eruption.

*Hilming* and *Pedersen* (1940) discovered in investigations on people of Greenland that at the age of 25—30 years the gingiva began to recede from the dental necks.

*Kitchin* (1941) measured the cervical tooth exposure in 200 cases of which 50 were 20—29 years and 50 50—59 years of age. Each group was composed of half males and half females. In the younger age group 15.5 % of all the teeth exhibited cervical exposure. In the 50—59 year group, 57.7 %. Exposure (measured mid-labially or mid-buccally, or along the molar's midline of the mesial root) of 1 mm or more was found in 58 % in the 20—29 age class. In the 50—59 age class in 94 %.

*Ervin & Bucher* (1944) give an account of an investigation of 1,252 patients of whom 58 % were female. They recorded all cases where at least 1 mm of the root surface was exposed. In the 20—29 years group

(413 persons) there were, in 60.4 % of the cases, one or more such teeth. In the oldest age group, 50 years and above, (132 persons) exposure was found in 96.6 %. The average number of teeth with root exposed in the above was 4.8 per person in the 20—29 year class, increasing to 10.2 in the oldest group. Men had a greater number of exposed roots than women.

*Riffle* (1950) examined 478 extracted teeth. On each tooth the distance from the cemento-enamel junction to the line of the clinging attached fibres of the periodontal membrane was measured. The teeth were then arranged according to age. It was then apparent that the older the group the nearer to the apex the line of severed periodontal fibres was situated.

*Hulin* (1941) performed an examination of crania from some 50 subjects chosen for their good dentitions. The jaws accordingly held all or practically all their teeth. The teeth were well fixed, the alveolar margin well-defined and the articulation normal, or nearly so. The jaws were undeformed. The subjects were 20—80 years of age. Hulin measured the distance between the alveolar margin and the cemento-enamel junction on the inner and outer surfaces of the teeth. These measurements were used for the determination of the average value of the exposed root surface for each decade from 20 to 80 years, as shown for the upper incisors in the table below.

*Physiological atrophy of the alveolar margin — upper incisors — Hulin*

| | Outer surfaces | Inner surfaces |
|---|---|---|
| 20—30 years ..... | 2.35 mm | 0.67 mm |
| 30—40 „ ..... | 2.94 „ | 2.25 „ |
| 40—50 „ ..... | 3.30 „ | 2.50 „ |
| 50—60 „ ..... | 3.76 „ | 2.92 „ |
| 60—70 „ ..... | 3.97 „ | 2.35 „ |
| 70—80 „ ..... | 5.00 „ | 4.00 „ |

Clearly, 50 subjects is too little material to justify the expectation of a reliable result with so narrow an age grouping. Hulin's value should therefore be taken with reserve.

With respect to gingival pocket conditions, reference is made to the section on the gingival pockets further on in this chapter.

From the above investigations it appears that there is strong evidence for the existance of continuous eruption of the teeth.

## Gingival pockets

The literature provides a number of accounts concerning the depth of gingival pockets. The investigations which are most fully reported are in general histological.

*Orban & Köhler* (1924) made comprehensive microscopic measurements. They reached the following results with respect to the four upper incisors.

On subjects of 19—30 years of age, 21 pockets were measured, of which all but three were situated proximally. The average depth was 0.88 mm. On all subjects of 19—50 years 72 pockets were measured with an average depth of 1.0 mm. Of these 72 pockets, 30 lay proximally with a mean depth of 1.17 mm, while the others lay next to the free surfaces of the tooth and had an average depth of 0.88 mm. To these values should be added the average shrinkage of 0.17 mm. All together 356 pockets with unbroken epithelial covering — "physiologic pockets" — were measured and these varied in depth between 0.00 mm and over 5 mm. The arithmetic mean of all these pockets (not taken only from the upper anterior teeth) was 0.84 mm, taking shrinkage into consideration.

One gets the impression, then, that the histologically measured depths are small, a fact which may depend on the process of shrinkage during the technical procedure. Orban & Köhler mentioned in their article how the shrinkage can be measured with the aid of calculus deposits on the root; in this way the obtained results can be corrected.

*Häupl & Lang* (1927) made a histological investigation on 100 subjects. The number of pockets measured is not given. From the results of the examination it appears that the physiologic pocket (sulcus) is very shallow, and often non-existent.

The term "physiologic" gingival sulcus is frequently found in the literature without its being clearly defined. Häupl & Lang, and Orban & Köhler state however that the pathologic pocket differs from the physiologic sulcus in that the former shows more or less extensive injuries of the epithelial cells constituting the base of the pocket. This statement may be of value to a histological investigation, but leaves one vague when it comes to a clinical examination.

*James & Counsell* (1927) investigated histologically material consisting of over 100 cases, chiefly pathological. There were 20 persons

under the age of 17 years who could be termed normal cases, or cases with earlier pathologic changes. The authors state that every depth of the pocket must be considered as pathologic.

*Becks* (1929) came to the conclusion from his histological investigations that a pocket can be considered pathologic only when the normal depth of approximately 1 mm has been exceeded and when this has been accompanied clinically by bone disturbances and inflammation.

*Skillen* (1931) conducted histologic investigations on a small number of teeth (10) of subjects aged 50—64 years. Labially, the depth was 0 mm in 7 cases, not more than 0.7 mm in 2 cases and in one case unmeasurable. Lingually, the pocket was 0 mm in three cases and not more than 0.9 mm in 6 cases, with one unmeasurable.

*Blumentritt* (1926) measured the physiological depth of the sulcus of living humans with a narrow German silver blade. Only cases with clinically normal gingiva were included in the examination. In the determination of the mean value only pockets with a depth of up to 1.55 mm were accepted since he always found with greater pockets that there was some trace of pathologic change (e. g. calculus, pus, hyperaemic gingiva, detritus and too great a width). Of 151 physiologic gingival sulcus of 20—30 year old people, the mean for the sub-groups was between 1.02—1.12 mm on the vestibular side and 1.18—1.30 mm orally. Of 24 physiologic sulcus of subjects of 60—82 years, the values were 1.20 and 1.23 mm respectively.

*Gottlieb* (1928) and *Coolidge* (1931), among others, state that the depth of the pocket is extremely variable and that it is impossible to settle on any normal value. The term "ideal condition" has instead been applied, which implies the absence of pockets.

In order to obtain a survey of the mean values given in the literature the following table is provided.

With all particulars on pockets it should be borne in mind that they can vary considerably at different places in the mouth; in fact, at different points around the same tooth.

At practically all ages the depth of the pocket is greater on the oral side than on the vestibular — a conclusion reached by *Blumentritt* from his investigation of 1926. He made some 1,000 measurements on this occasion. The deepest pocket is generally situated interdentally, say *Stärke* (1947), *Hammer, Reichenbach & Wannenmacher* (1941).

*Table 1. The mean value of the sulcus*

| Authors | No. of cases | Depth of pocket | Age | Remarks |
|---|---|---|---|---|
| Kantorowitz ..... | — | 1—1.5 mm | adults | according to Blumentritt |
| Weski (1922) ..... | — | 1.5 mm | | after completed eruption |
| Orban-Köhler (1924) | 356 pockets | 0.84 mm | 1¾—50 years | pockets with unbroken epithelial covering |
| Box (1924) ..... | — | approx. 2 mm | — | normal pockets |
| Häupl-Lang (1927) ... | — | shallow, sometimes 0 mm | — | physiologic pockets |
| Blumentritt (1926) ... | 151 pockets | 1.02—1.30 mm | 20—30 years | physiologic pockets |
| | 24 „ | 1.20—1.23 mm | 60—82 years | physiologic pockets |
| James & Counsell (1927) | 100 cases | 0 mm | — | physiologic pockets |
| Skillen (1931) ..... | 18 pockets | less than ½ mm | 50—64 years | |
| Kronfeld (1933) ..... | — | 0.1—1 mm | — | most values |

*Harndt* (1950) says that in inflammatory parodontopathies the pocket is generally deepest proximally. *Castenfelt* (1950) found the same thing and in his statistically treated clinical material the mean of the central values on the free surfaces orally and vestibularly is about 60 % of the mean of the two proximal values. Of the two central values the oral mean is greater than the vestibular. His investigation also deals with pathological cases, generally chronic parodontopathies of adults. It may be mentioned in passing that Castenfelt used a mensuration technique which was similar to that of the present author (see Chapter III). The chief difference is that his probe had a coarser calibration (one mark for every other millimetre), and that he did not always measure along the middle of the anatomic surface of the tooth in determining the central values, but along a line mid-way between the mesial and distal proximal points.

*Riffle* (1950) states that the base of the pocket is situated farther from the cemento-enamel junction buccally and lingually than proximally.

It is probable that the depth of the pocket shows a higher value among older people, but there are statements to the contrary in the literature. *Kronfeld* (1933) states that the age of the subject has no bearing on the depth of the pocket.

The formation of pockets is generally considered unfavourable to the periodontium. *Hammer, Reichenbach & Wannenmacher* write to this effect in their work of 1941, saying that the pocket, whatever the manner of its formation, always provides the opportunity for retention of detritus and the formation of concrement which has undoubtedly a deleterious effect on the labile periodontium.

*James & Counsell* (1927) and *Kranz & Falck* (1922) state that calculus is to be found in all cases with pathologic pockets.

## Enamel margin—alveolar bone distance

The distance from the enamel margin of the tooth to the alveolar bone may vary from one person to another. Among the factors which have a bearing on this the following may be mentioned.

A. Factors involving a breaking down of the crest.

1. Resorption due to physiological causes, e. g. age resorption (*Kronfeld*, 1933; *Fish*, 1946; *Thomas*, 1946; *Harndt*, 1950; et alii) or reduced function (*Euler*, 1923).

2. Inflammation, primarily in the gingiva (*Kronfeld*, 1933; *Adrion*, 1938; *Frölich*, 1948; et alii). This does not by any means imply that inflammation always results in resorption. *Goldman* (1942), who studied microscopical sections from jaws of 30 subjects, shows that the alveolar crest may show apposition of bone even in the presence of gingival inflammation.

3. Abnormal occlusal stress (*Kronfeld*, 1933; *Miller*, 1943; *Norberg*, 1950; et alii).

4. Disturbance of some organic system e. g. in diffuse atrophy (*Gottlieb & Orban*, 1933; *Kronfeld*, 1933; et alii).

B. Factors which bring about an active eruption of the tooth.

1. Physiological in continuous eruption.

2. Pathological in various periodontal diseases, and often on extraction or destruction of the antagonist. (*Loos*, 1909.)

A determination of the position of the bone margin vis-à-vis the tooth may be made in different ways. With living subjects an x-ray examination is the only conceivable means.

*Dieck* (1911) was the first to point to the importance of x-rays in this respect.

*Cieszyński* (1926) states that the alveolar crest is normally visible ½—1½ mm below the enamel margin (with normal length of tooth and the film close to the alveolar process).

*Fixott* (1932) examined 25,112 teeth with x-rays and found bone resorption from the normal position on the root to the coronal third in 36.5 %, and beyond the coronal third of rooth in 13.4 %. He states (1934) that the normal alveolar process appears directly below the cemento-enamel junction on the x-ray film.

*Sedginise* (1932) states that the inter-alveolar septum extends normally as far as the cemento-enamel junction.

The three last authors do not mention the age of the material; neither is the technique described in detail.

*Herulf* (1950) took measurements on x-ray film of the distance between the alveolar margin and the enamel junction. The material for the investigation consisted of the lower incisor region of men and women of 20—30 years of age. X-ray examinations were made along lines which bear close similarity to those followed by the present author. The dental film was fixed in the bite block film holder and was adjusted by sigthing so that the film was parallel to the longitudinal axis of the tooth. The axial ray was directed perpendicularly to the dental arch through the mid-septum and towards the plane of the film. In the measurements the perpendicular distance was determined from the septum tip to the line joining the most incisally placed enamel margin of two adjacent teeth.

In the group "men with normal gingiva" Herulf measured the distance mentioned between the medial lower incisors (154 septa) and between the medial and lateral lower incisors (230 septa). In the first

case the septa lie on the average 1.2 mm below the enamel margin. In the latter case 1.0 mm below. If one puts together the measurements of men and women a statistically significant difference is found to exist between these two points of measurement. A few persons were found with septa which reached up to the enamel margin.

In cases with the gingiva somewhat changed pathologically Herulf measured on men 308 lateral septa and 197 mid-septa. The level of the mid-septa was on the average 1.6 mm below the enamel margin, and the lateral septa 1.3 mm. For the combined sexes all three septa indicated significant differences in relation to the normal gingiva group.

When calculus was present the mean for all differences in level is consistently higher than otherwise.

*Orban & Köhler* (1924) made histological investigations on necropsy material, measuring the enamel margin—alveolar margin distance. The proximal distance was measured on 30 upper incisors of subjects 19—50 years of age. The distance varied between 0.75 and 5.0 mm with an average of 1.7 mm; in the 19—30 year sub-group of the above 16 proximal points with a distance varying between 0.75 and 3.22 mm were measured. The average was here 1.4 mm.

*Box* (1924) states, without giving any account of the work, that the top of the alveolar crest lies on an average 2 mm below the cemento-enamel junction.

*Hulin* (1941), as mentioned above, performed measurements directly on crania of deceased persons of different ages.

*Bohres* (1932) made a combined x-ray and microscopic investigation on necropsy material of 16 subjects of different ages. She found new bone formation in connection with the function of the teeth. In general, there was mesial resorption and distal rebuilding.

## Attrition[1]

It is commonly held that, from the point of view of stress, the tooth is a two armed lever. The lever arm of the load is somewhat longer than that part of the tooth which is not invested in the jaw. The complementary arm of the lever is the remaining portion of the

[1] In the choice of the term "attrition" the author has followed common English usage. Attrition results from the use of the teeth. Abrasion results from abuse of the teeth (*Klatsky*, 1939).

tooth. If, with increasing age, the alveolar bone breaks down from its free margin the fixed lever arm becomes shorter and the stressed arm longer, an occurence which leads to an unsatisfactory situation. This is in many cases compensated for, however, by occlusal wearing of the tooth. Attrition is therefore important to the good condition of the periodontium. (*Öhrlein,* 1927; *MacMillan,* 1928; *Gottlieb, Orban & Diamond,* 1938; *de Jonge,* 1950; et alii).

Another conception of the value of attrition is put forward by *Adloff,* 1938. He contests that wear is a practical and expedient process since at bottom all wear is injurious. This generalization can hardly be discussed in more detail. However, he points out that the teeth with cusps intact must be better suited to the mastication of food. He thinks that wear is rendered possible by the body's inability to prepare a material harder than enamel; that is, wear arises through an inherent imperfection of the system.

The extent of the wear depends above all on the kinds of food and the hardness of the dental tissues; secondary factors are, for example, the elasticity of the periodontium and spongiosa, the chewing capacity and the occlusal relationship. (*Bǎstýř,* 1909; *de Jonge,* 1950). A factor sometimes of significance in wearing of the teeth is "idle grinding". (*Gottlieb, Orban & Diamond,* 1938.)

One finds a higher degree of attrition, even at quite an early age, among people who are using their teeth to an abnormal extent. *Hilming & Pedersen* (1940) showed that Eskimo women who used the anterior teeth in the preparation of skins have more pronounced attrition than others. *Kientsing* (1929) described similar conditions among Chinese who have a marked habit of crushing various types of seeds between their front teeth.

More comprehensive and detailed measurement of the extent of attrition it has not been possible to find in the literature. In general, attrition is reported only in approximate measure, e. g. in degrees, depending on where in the dental substance the attrition surface lies — in the enamel, dentine, secondary dentine, pulp chamber, etc. (*Thompson,* 1900; *Kronfeld,* 1933; *Klatsky,* 1939; *Thoma,* 1944; *Gustafson,* 1947; et alii.)

As an example of some measurements of attrition the case of *Nicholls* (1914) may be cited: he studied a series of crania of aboriginals of Australia and Tasmania, and found that the teeth were

worn about 1 mm for every five or six years. The natives' teeth would, however, have been exposed to exceptionally heavy stress owing to their type of food.

From the investigation of *Westin* and collaborators (1934), particulars of two age-groups of men have been obtained which correspond roughly with those of the present author. They found that 318 men, or 90 % of the subjects examined, of 19—30 years of age did not display attrition. Over 65 years, attrition was absent in 9, or 25 %, of the cases. Heavy attrition appeared in 1 % of the younger group and 47 % of the older.

If attrition does not keep pace with the lengthening of the free dental crown — and this is thought to be the case with man (*Gottlieb* and collaborators, 1938) — then in spite of wear the free crown will become longer with increasing age. *Blumentritt* points to this condition for the visible crown in his investigation.

## The gingiva

It is often emphasized in the literature that good lighting should be used in the examination of the gingiva (e. g. *Schour & Massler,* 1947). In this respect the anterior part of the mouth affords the best conditions for examination. The anterior region is, furthermore, suitable material for the investigation, certain authors giving this part as having the greatest frequency of gingivitis. *King* (1945) found in his investigations that, in some age classes at least, this part of the gingiva was more disposed to disease than others. *Harndt* (1950), in a statistical treatment of an investigation on the population of a large town, found that marginal diseases are most commonly affecting the front teeth. *Marshall-Day & Shourie* (1950) discovered on examination of 823 children of ages 6—18 years that the highest frequency of gingival diseases applied to the upper labial region. They warn against estimating the gingiva's condition in the whole mouth by the examination of just one region.

During an examination of the gingiva it is possible to observe symptoms of inflammation. The clinical symptom to which one pays most regard in this connection is perhaps reddening of the free gingiva and bleeding on touching, or even spontaneously. (*Merritt,* 1945; *Dawson,* 1948). The frequency of inflammation in histological in-

vestigations is appreciably greater than in clinical. In practically all investigated cases one or another sign of inflammation is found under the microscope. (*Weski,* 1922; *Kranz & Falck,* 1922; *Häupl & Lang,* 1927). Some authors, for example *Held & Nally* (1948), consider that inflammatory cellular infiltration of the gingival margin cannot alone be considered as pathologic, but that such a diagnosis would demand some observable change in the blood vessel system. In judging the condition of the periodontium one should be on one's guard against attaching importance only to inflammatory changes of the gingiva. In certain cases periodontal injuries are to be found unaccompanied by inflammatory symptoms (*Fleischmann & Gottlieb,* 1920; *Tenenbaum* and collaborators, 1950; etc.).

The frequency of gingival changes has been the subject of diverse investigations. *King* (1945) studied detailed conditions of the gingiva in the incisor and canine regions of each jaw of children and expectant and nursing mothers. His results show that of 130 young adults of Dundee of 16—18 years of age, divided into sub-groups, gingival diseases were present in 55.6—92.7 % of them. The corresponding figures in the Harpenden Institution were 53.8—71.4 % (47 examined). Boys more often had gingival diseases than girls.

Some authors have made comparative investigations of the condition of the gingiva among different age groups. Table 2 has been compiled to show the figures. Where it was possible, only particulars of men were taken. If the authors reported several groups, then those selected for the table were the ones most closely resembling the present author's younger group (approx. 20—30 years of age), and were in addition, the oldest of the reported groups. This selection was made to facilitate comparisons with the present author's material.

In addition to these there has also been included from the literature some information from the gingival examinations of separate age-groups corresponding to the present author's younger group (Table 3). One difference, however, is that this information is in general based on the gingival condition of the whole mouth.

The details on the number of persons with healthy gingiva varies widely. All authors in Table 2, with the exception of *Westin,* found poorer conditions of the gingiva among the older age groups.

*Westin & Wold* (1943) and *Smart* (1944) give a higher frequency of gingivitis among the lower social groups.

*Table 2. Incidence of healthy gingiva in various age groups*

| Authors | No. examined | Age | Healthy gingiva | Remarks |
|---|---|---|---|---|
| *Westin* and collaborators (1934) | 162 | 19—30 years | 36 % | |
| | 27 | over 65 years | 48 % | Males only |
| *Hilming & Pedersen* (1940) | 83 | 22—35 years | 12 % | East Greenland |
| | 52 | 36 years and over | 1.9 % | eskimos |
| *MacDonald* (1943) | 411 | under 30 years | 82.3 % | |
| | 183 | over 30 years | 62.3 % | Ship's company |
| *Smart* (1944) | 361 | under 25 years | 68 % | Men of R.A.F. |
| | 191 | 36 years and over | 26 % | |
| *Schour & Masler* (1947) | 602 | 21—30 years | 28 % | In the majority of cases only labial gingiva of the lower anterior region was examined Subjects from Italian towns |
| | 553 | 51—60 years | 2 % | |
| *Dawson* (1948) | 403 | 21—30 years | 1.2 % | Egyptian |
| | 103 | 41 years and over | 0 % | peasants Males |

*Table 3. Information from the literature on the percentage of healthy gingiva*

| Authors | No. examined | Age | No gingivitis | Remarks |
|---|---|---|---|---|
| *Black, A.D.* (1913) | 500 | 20—35 years | 5 % | Selected good material e. g. cases with injured periodontal membrane were rejected |
| *Westin & Wold* (1943) | 6468 | chiefly 20 years of age | 31 % | Male conscripts |
| *Bober* and collaborators (1943) | 644 | 20—25 years | 82.4 % | Students |
| | 894 | 20—25 years | 52.35 % | Men having the same diet |
| *Linghorne* and collaborators (1946) | 1448 | 30 years | 80 % | Men of R.C.A.F. |
| *Pindborg* (1947) | 1433 | 16—28 years | 26.5 % | Danish Royal Marines |
| *Herulf* (1950) | 361 | 20—29 years | 55 % | Male students : lower anterior region examined |

## Causes of periodontal diseases

Among the possible causes or contributory causes of gingivitis and resorption of the alveolar bone the following can be named.

*Irregular positioning of the teeth*

*Herulf* (1950) found no significant or probable differences between the levels of the bone septum in normal and abnormal positioning of the teeth. Changes in the gingiva were found in approximately the same percentage of cases with normal spacing (51 %) as with crowded teeth (58 %). In the case of diastemas it is less common to find gingival changes. This result might however be due to chance. *Wachsman* (1950) examined 956 cases of 5—18 years of age, who were treated in the orthodontic department. Of these, 7 % had gingivitis. The frequency of gingivitis among those with compression was 13 %.

*Caries*

*Hilming & Pedersen* (1940) found in their investigation in East Greenland of 702 Eskimos that the incidence of gingivitis was high in spite of a very low caries frequency in that region (*Pedersen,* 1938). The same was the case in *Day's* (1944) examination of 200 undernourished Indian boys. *Miller & Seidler* (1940) made x-ray examinations of 1,003 persons of 11—60 years of age and found no correlation between caries and periodontoclasia. *King* (1945) discovered no constant relationship between the presence of caries and the incidence or extent of gum disease. *Shay & Smart* (1945) examined two groups of airmen, 98 persons in all, and found normal gingiva in 61.5 % without caries, and in 33.3 % with caries. *Savara* (1950) examined 2,774 high school students ranging in age from 14—17 years. Only in the group with severe gingivitis was the caries incidence high. In the other groups no connection was found.

*Injuries arising through dental treatment*

*Morgenroth* (1940) has conducted histological experiments on dogs and shown convincingly that trauma through dental treatment can result in permanent and progressive periodontal injuries. *Shay & Smart* (1945) found a rise in the percentage of healthy gingiva with an

increase in the number of fillings, while *Gottlieb, Orban & Diamond* (1938) were of the opinion that injuries arising through dental treatment were one cause of gingivitis. A large number of authors have shown with x-rays that resorption of the alveolar bone can be caused by incorrect dental treatment.

*Calculus*

Most authors are in agreement over the connection between the incidence of calculus and the periodontal defects (*Black,* 1913; *Westin & Wold,* 1943; *Shay & Smart,* 1945; *King,* 1945; *Pindborg,* 1947; *Herulf,* 1950). The higher frequency of gingival inflammation among older people may possibly be connected with the higher incidence of calculus among them mentioned by *Boul* (1923), *Dawson* (1948), et alii.

Pindborg, King and Herulf found, however, that clinically healthy gingiva can quite well exist in spite of simultaneous calculus deposits.

*Oral hygiene*

*Westin & Wold* (1943) found in their examination of 6,468 male 20-year-olds that of 100 men who exercised daily oral hygiene over a half have normal gingiva, while of 100 men unacquainted with oral hygiene normal gingiva is found only in 7 cases. Further, these authors state that of 100 cases who obtain annual dental treatment 56 have normal gingiva, while of 100 cases with no treatment the number is only 17. From this situation and from the relationship between carious defects and gingivitis they draw the conclusion that gingivitis arises to a great extent as a result of neglect of the teeth. They mention in this connection the importance of economic and social factors. At the same time, however, they assert that the incidence of gingivitis is closely related to the carious defects of the bite.

The significance of deficient oral hygiene to the occurence of periodontitis has given rise to the name "Schmutz pyorrhea" (*Gottlieb & Orban,* 1933).

*Kring* (1950) found, however, that of 211 adults who brushed their teeth daily only 3.3 % had normal gingiva.

*Westin & Wold* (1943) found that severe forms of gingivitis are more frequent among those who do not exhibit ground and worn teeth.

## Summary

Strong arguments have been put forward for the existance of continuous eruption. The question as to which factors play the greatest part in this occurence — physiological or pathological — do not, however, seem to be clearly exposed.

With regard to the information from the literature on the depth of the pockets, there are wide divergencies. In general only mean values are given, without closer details of how the measurements were made and what material was available. It seems, also, uncertain in many cases just what the various authors mean when they speak of physiologic or normal gingival pockets.

The relative position of the tooth (enamel margin) and the alveolar crest has been the subject of measurements in a few rather comprehensive investigations. The determination of the degree of attrition is on the other hand generally performed by very uncertain methods. The incidence of gingivitis varies to a large degree even within similar age and sex groups. This may of course depend on the differences in the investigation methods but is probably chiefly due to the different living conditions (diet, hygiene, etc.) among the various groups examined. With respect to those factors which may contribute to the appearence of gingivitis, there does not seem to be any consistent principle with the exception of a connection between gingivitis and calculus. Which of these is the cause and which the effect they do not say.

The problems which are not fully explained or which have been completely neglected — those that have for that reason stimulated the present author to further investigations — are principally the following. At what rate, on the average, does the process of continuous eruption go forward and to what degree is the growth of the crown prevented by attrition? In what way do the depth of the gingival pocket and the incidence of gingivitis change with increase in age? Is it possible to discover by clinical investigation some cause or contributory cause of periodontal injury?

Further, it would be interesting to obtain an analysis of the periodontal data from some Swedish groups.

# CHAPTER II

## Nomenclature

In periodontology it is not uncommon to find different authors using two or three terms for the same thing. It would therefore appear desirable to give some definitions of the terms that are used in this work. For the most part the nomenclature used is that proposed by the 1949 Nomenclature Committee of the American Academy of Periodontology (*Lyons, Kerr & Hine*, 1950). In certain cases, however, modifications and additions to this terminology have been thought suitable.

*Periodontium.* The investing and supporting tissues of the tooth, namely the periodontal membrane, gingiva, cementum and the alveolar bone. In european literature the terms paradentium and parodontium are often used as synonyms.

*Gingival sulcus.* The shallow groove around a tooth, bounded on one side by the surface of the tooth and on the other by the epithelium, which lines the free margin of the gingiva. This term designates the "normal" condition as distinguished from the gingival and periodontal pocket.

*Gingival pocket.* The gingival pocket may be defined as a pathologically deepened sulcus.

*Periodontal pocket.* A periodontal pocket may be defined as a gingival sulcus pathologically deepened by periodontal disease. It is bordered on one side by the tooth and on the other by gingival tissue. Its base is limited by the epithelial attachment which is usually not intact in this area. The chief features of the periodontal pocket are the ulceration of the epithelium lining the pocket and the inflammation of the gingival corium.

As it does not always seem possible in a *clinical* examination to distinguish between a physiologic sulcus and a pathologic pocket, the common term "pocket" has often been used for all three conditions.

*Dental calculus.* Concretions deposited on the teeth consisting of inorganic salts deposited in an organic matrix. One can classify dental calculus roughly into supra-gingival and sub-gingival calculus.

The term "dental crown" is found in the periodontological literature with the following meanings:

*Anatomic crown* = Dental crown down as far as the cementoenamel junction (x-ray enamel margin).

*Visible crown* = That part of the tooth situated orally to the free gingiva (*Oppice*, according to *Orban & Müller*, 1929).

*Clinical crown* = That part of the tooth which is situated orally of the base of the gingival pocket (*Gottlieb*, 1928).

For the sake of brevity that part of the tooth not embedded in the alveolar bone is termed the physiologic crown.

## CHAPTER III

# Methods used

The recording of measurements of interest in the periodontium calls for the use of various techniques of measurements. The depth of the gingival pocket is of course most conveniently determined intraorally. The position of the gingival margin (round the tooth) may also be measured in the mouth, but such a procedure proved slightly impracticable, while the figures obtained were not as accurate as those obtained on a good plaster cast. The position of the cementoenamel junction was of necessity determined by x-ray photography, at least for the majority of the younger subjects. The same method was applied to the alveolar crest. It was thus necessary to make measurements intra-orally, on the cast and on the x-ray film. In order to establish the relationship between these figures some basic reference common to the three different modes of measurement is required.

The basis employed for the measurements enumerated below is the following. All distances are measured along an imaginary axis — the standard axis — within the crown of the tooth. The reference point in the system of measurement is where this axis intersects the incisal edge of the tooth. From any point whose distance to the reference point is required, a normal is drawn to the standard axis; the point where the normal intersects the axis marks off the required length.

In the construction of the standard axis the crown of the tooth may be assumed to be divided into two halves of equal maximum sagittal width by a plane (the bisecting plane) through the incisal edge and directed towards the root (fig. 1). It is found that this plane also passes through — or very close to — the morphological contact points of the tooth, and at the gingival margin divides the traverse section of the root into two parts of roughly the same width. Further, a line

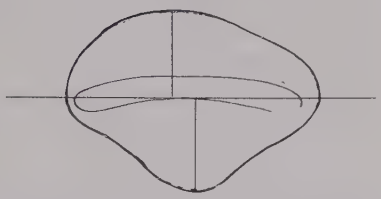


*Fig. 1. The bisecting plane, which divides the crown of the tooth into two halves with the same maximum sagittal width, seen from the incisal edge.*

(the longitudinal axis) is drawn along the labial surface of the tooth, dividing the surface into two more or less equal parts (fig. 2).

Assuming the existance of a new plane through this axis and perpendicular to the first plane, the two planes will intersect along a line

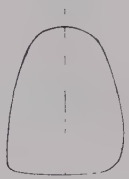


*Fig. 2. The longitudinal axis of the labial surface.*

which is the required standard axis (fig. 3). The construction of the standard axis and the actual performance of the measurements is quite simple, in spite of the fact that the mathematical definitions of the axis would appear somewhat involved. The advantages of taking measurements along an axis in the centre of the crown instead of along the surface of the tooth are obvious. The irregular curvature of the surface of the tooth would, in the latter case, effect the measured lengths and render difficult any comparison between different teeth.

The reference point lies in the centre of the edge, which is preferable to locating it in one of the incisal corners. These are more or less rounded, and small variations in the position of the reference point may result in comparatively large differences in measurement. Furthermore, the corners are more liable to traumatic injury than the centre of the edge.

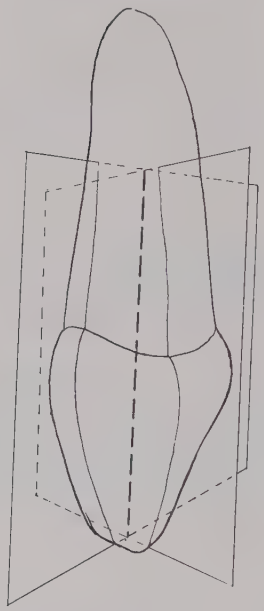


*Fig. 3. The two planes whose line of intersection gives the standard axis.*

The casts used in the investigation were prepared in stone plaster from impressions in hydrocolloidal compound (D.P.).

In order to record the course of the free gingival margin around the tooth, normals were drawn to the reference axis from various points on the periphery of the tooth (fig. 4). The distance from the point of intersection of the normal and the standard axis to the reference point was measured. The points from which the normals were constructed were (a) those where the gingival margin was met by the longitudinal axis of the labial surface of the crown and the corresponding lingual points, and (b) the four points on the gingival margin which lie so near the contact points (surfaces) that it is possible to obtain correct values mesiolingually, distolingually, mesiolabially and distolabially. These points do not always correspond to fixed anatomical points on the tooth. The distances between them may vary on account of the width of the contact surface, the crowding of the teeth, etc. The relative positions of these points were therefore established by angular determinations (see below). The measurements were carried out on casts.

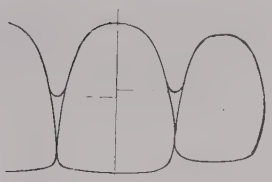


*Fig. 4. The normals drawn from the distolabial and mesiolabial measuring points on the free gingival margin to the standard axis.*

The longitudinal axes were drawn on the labial and lingual surfaces of the crowns of the teeth and the points from which the measurements were made, marked proximally. The cast was then placed with labial surface uppermost on a stand of which the plate was adjustable, connected to the foot through a ball joint (fig. 5). The cast was oriented in space so that the bisecting plane on the crown of the tooth to be measured lay horizontally. The adjustment was checked with the apparatus shown in fig. 5. This consists of a small horizontally fixed metal plate which can be moved vertically. This is placed against the edge of the tooth and, by sighting, the accuracy of the adjustment can be checked by observing whether equal sagittal areas of the crown appear above and below the metal plate. The cast and the stand are then moved under a measuring microscope which is so constructed that the tube, apart from the usual adjustments in the vertical plane, is also movable along a horizontal line.

Initially, the stand is turned so that the labial longitudinal axis on the dental crown in question is at right-angles to the direction of measurement of the microscope. The cross-wires are focussed on one of the proximal measuring points and by moving the microscope tube laterally one can draw the normal, as it were. A mark is made on the labial, longitudinal axis where the normal intersects it. The bisecting plane having been set horizontally by turning the plate, this mark will, in the measurements, correspond to the point of intersection of the normal and the standard axis. When the normal has been marked, the model is turned through ninety degrees and the distances then measured with the microscope (fig. 6). This permits a determination of the length to practically a hundredth of a millimetre. The labial surface finished, the cast is turned so that the lingual sur-

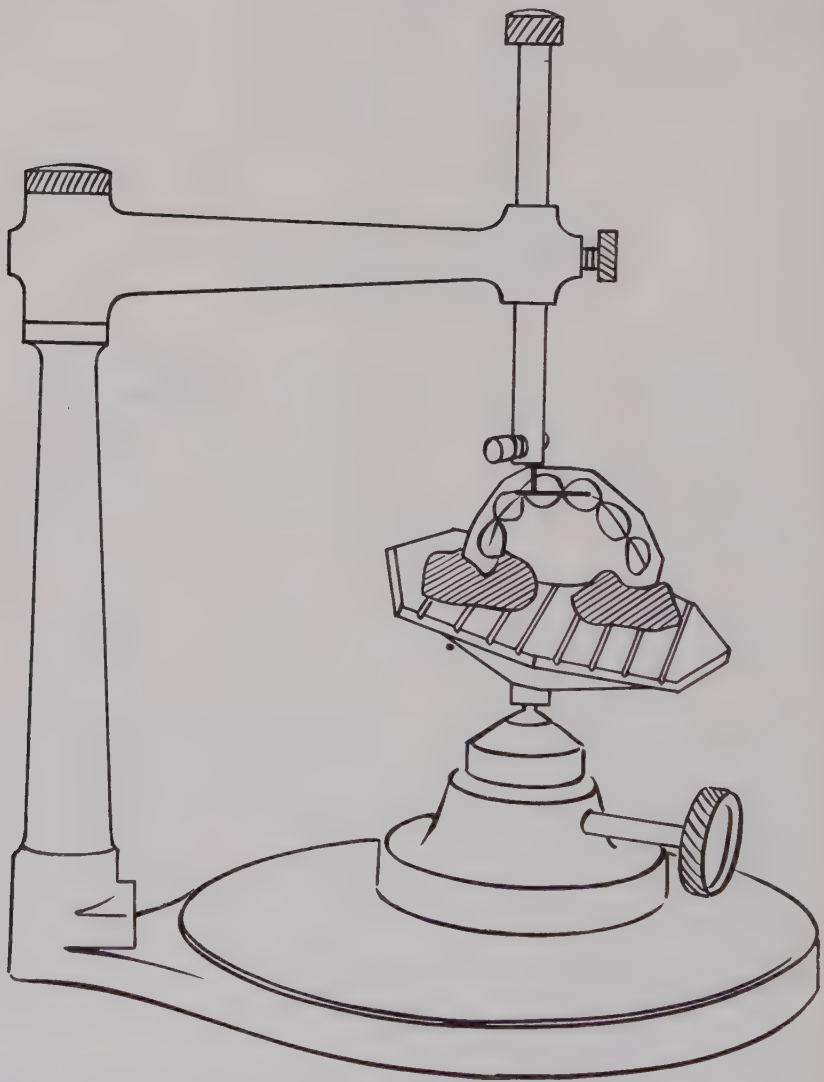


*Fig. 5. The cast placed on a stand for horizontal adjustment of the bisecting plane. Apparatus for checking of adjustment.*

face is uppermost. The adjustment of the bisecting plane etc. is carried out just as before, except that the intersections of the normals with the longitudinal axis of the lingual surface are now marked. The

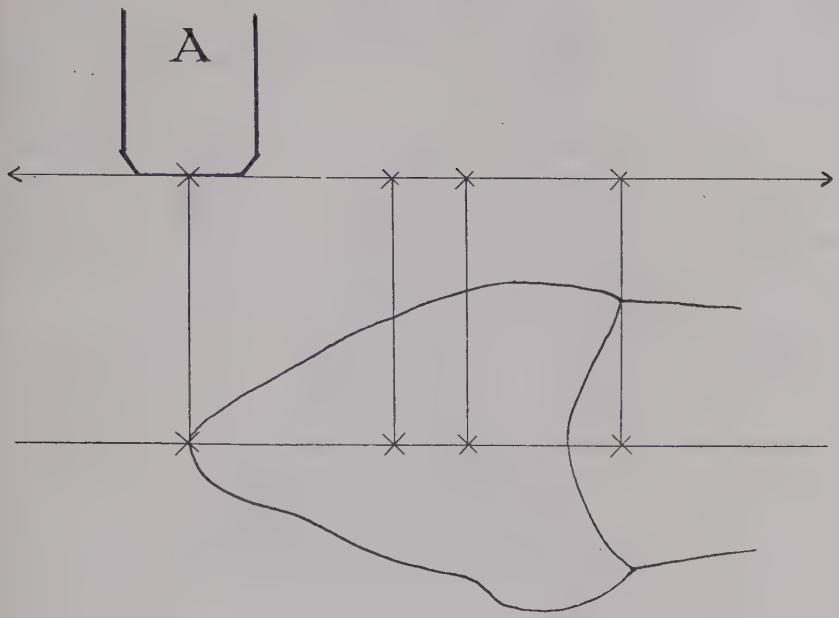
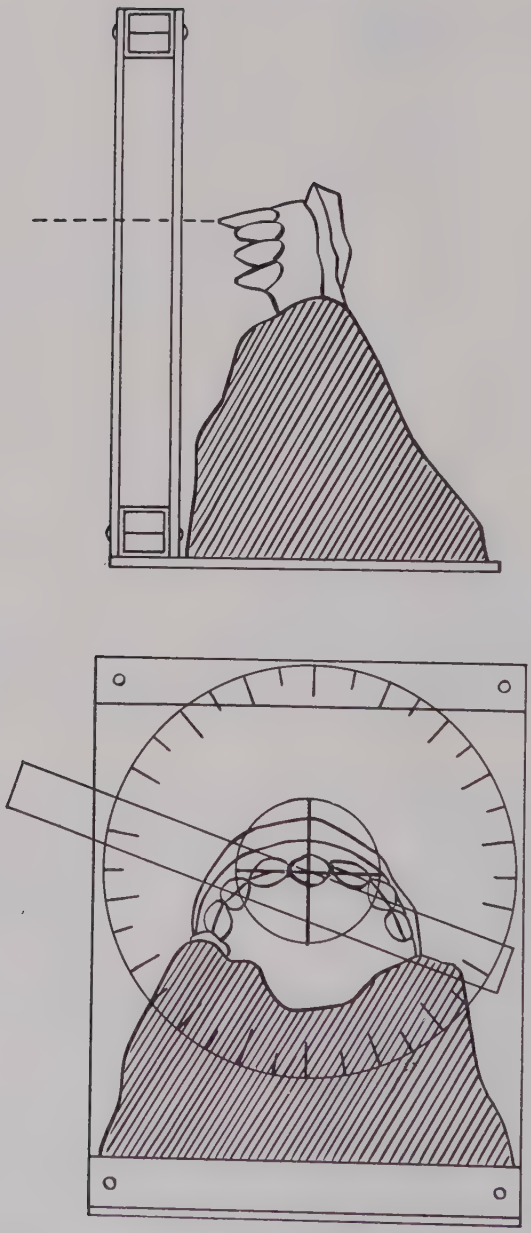



*Fig. 6. All marking are made on the labial and palatinal longitudinal axis, but since the tooth is oriented so that the standard axis lies horizontally and parallel to the direction of movement of the measuring microscope, the distances will be measured along the standard axis. A = The objective of the microscope.*

mensuration procedure is as described in the previous example. In order to see what differences appear when measuring lingually or labially, in the case of diastemas the same proximal point lengths were measured from both lingual and labial sides. The results are reported among the errors of the method.

In order to compare the gingival margin — incisal edge distances of various teeth, the measurements should preferably be performed on symmetrical points of the different teeth, on account of the garland shape of the gingival margin.

To determine the relative positions of the points, suppose the crown of the tooth circumscribed by a circle. Through the mid-point of the circle and perpendicularly to the plane of the circle passes the standard axis of the crown. The relationship between the positions of the different points around the tooth may now be expressed as the angle subtended at the centre of the circle.



*Figs. 7 and 8. Apparatus for determination of the relative position of the measuring points. In Fig. 7 seen from the side and in Fig. 8 seen from the point of view of the investigator.*

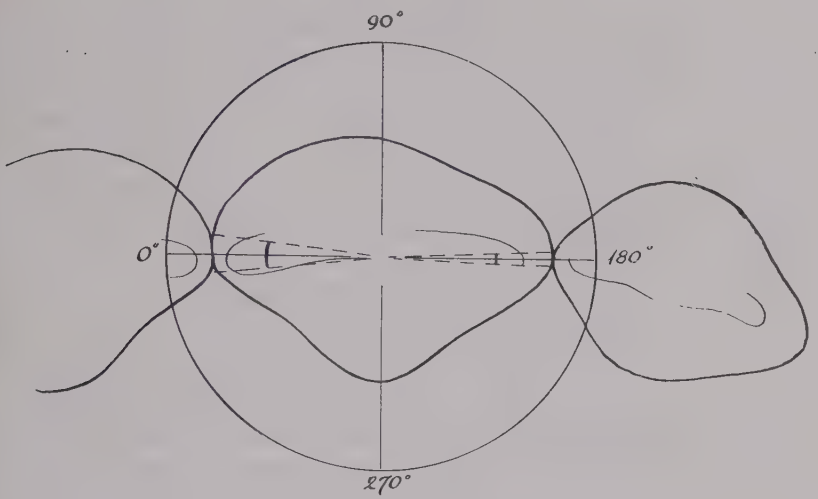



*Fig. 9. Determination of the mid-point angles between the proximal measuring points mesially and distally.*

In practice the procedure was as follows. An apparatus was used (fig. 7 and 8) consisting of two vertical, separated, parallel plexiglass plates. On one side of the plates the cast of the teeth was placed and from the opposite side the required angles were sighted.

The glass plate nearest the worker is provided with an etched circle calibrated in degrees. The mid-point of the circle is also marked on the glass. The second plate has a horizontal and a vertical line marked on it which cross at a point opposite the mid-point of the circle of the first plate. The cast is positioned with the aid of plasticine so that the horizontal part passes along the middle of the incisal edge of the tooth to be measured, dividing the tooth into two parts with equal sagittal length. The vertical part of the cross coincides with the longitudinal axes of the labial and lingual surfaces. The number of degrees giving the position of the different measuring points are sighted with a straight-edge (fig. 8 and 9). When sighting, the viewer's eyes should be so placed that the mid-points of the circle and the cross coincide.

Sometimes in diastema, the measurements could be made purely proximally, and hence at one point instead of both labio- and linguo-proximally. In the tables this single value has been taken for both labio- and palato-proximal.

In those cases where crowding of the teeth could not be excluded at the visual examination, the degree of crowding was determined on the cast with a slide-guage. The readings could be made to an accuracy of about 0.1 mm. The determinations were made, adhering closely to the method described by *Lundström* (1943, 1944). The degree of crowding was expressed by the difference $(T_1 + T_2) - G$, where $T_1$ and $T_2$ are the widths of the incisors of one side and $G$ is the space available for the two teeth in the dental arch. On each side where crowding was apparent measurements were taken. In any case where only three anterior teeth were present, the single difference was $T_1 - G$ or $T_2 - G$. The width of the tooth was measured by laying the specially narrowed ends of the slide-guage arms along the anatomical proximal surfaces of the crown parallel to the longitudinal axis drawn on the labial surface. The width of the tooth may often be made up of two partial lengths at different levels on account of the anatomic form of the crown (fig. 10).

The space a group of two teeth has at its disposal in the dental arch is equal to the linear distance between its points of contact with the neighbouring teeth, that is, for the group +1 & +2, the mesial contact points on +3 & 1+, and for the group 2+ & 1+ the mesial contact points on 3+ & +1. The required contact points lie where a tangent to the tooth, perpendicular to the dental arch, touches the tooth surface. The dental arch was defined so that its vertical projection passes through the cusps of the canine teeth and the contact point of the medial upper incisors. Occasionally this constitutes a surface and then the most advanced portion of the surface on the labial side is taken as the contact point.

The degree of crowding is stated in mm and tenths. If crowding existed on both sides then the sum of the two differences gives the degree. If crowding exists on one side only then the difference for that side alone is taken as the measure of the degree of crowding.

The degree of fixation of the teeth was determined clinically by testing the movement in a labio-lingual direction using a measurable pressure. Different degrees of mobility have not been recorded but only whether the tooth indicated more than ordinary mobility.

Any change in the gingiva was noted: e. g. reddened gingival margin, haemorrhage — spontaneous or on touching — and swelling.

Where diastemas appeared they were measured by means of metal

*Fig. 10. The width of the tooth may sometimes consist of two parts on different levels on account of the anatomic form.*

wires of diameters 1, 2, 3 or 4 mm. In this way different groups of diastemas were obtained. The class with the greatest diastema must of coarse be left open.

If it was uncertain whether or not diastemas existed a test was made by lightly pressing floss between the contact points of the teeth in question. The test was carried out intraorally.

The lengths of the anatomical and physiological crowns were obtained by x-ray technique. The term "anatomical crown" means the region between the enamel margin and the incisal edge of the tooth. The length of the anatomical crown can thus vary, depending on the point of the enamel margin from which the measurements are made. On the x-ray film the proximal enamel margins generally show up most distinctly, and these were the ones used in the investigation.

The term "physiological crown" denotes that part of the tooth which does not lie embedded in the jaw-bone. The measurement of this can also give different results depending on the point of the jaw-bone from which the measurements are taken. In this investigation the measurements were made from the free edge of the bone proximal to the tooth in question.

Sighting of the x-ray cone and the placing of the film pack was effected with respect to an imaginary plane (the bisecting plane) which could be said to divide the crown, from the incisal edge of the tooth, into two equal parts, the labial and the lingual. The film was placed intra-orally, parallel to the bisecting plane and at a distance of 2 cm from it. The tip of the x-ray cone was adjusted to a distance of 13 cm from the filmpack, i. e. 11 cm from the bisecting plane, and so oriented that the central ray was at right angles to the film and the

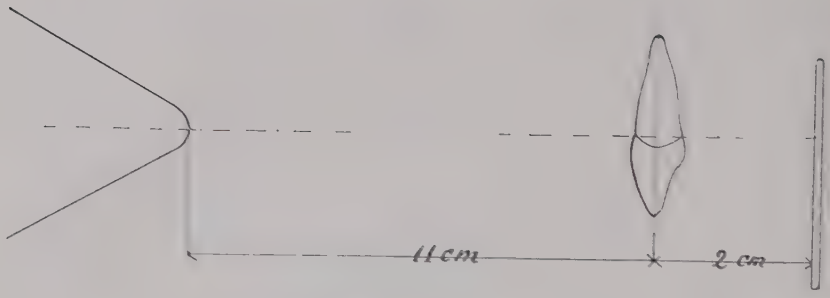



*Fig. 11. The relative position of the x-ray cone, tooth and film. The direction of the central ray is marked.*

bisecting plane (fig. 11). Further, the axial ray was directed so that it impinged on the labial surface of the crown at the level of the labial cementoenamel junction. The distance from the focus of the x-ray tube to the tip of the cone was, in the case of the apparatus in use, 17.5 cm. The distance from the focus to the bisecting plane was accordingly 28.5 cm and to the film 30.5 cm. The resulting x-ray picture was enlarged by a linear factor of 30.5/28.5.

Ordinary dental film is in most cases too wide for use in this case. It is necessary, of course, that the film should lie flat and not curved even at the edges. The ordinary dental film was therefore cut to the required width, in this case somewhat more than the width of a front tooth. The film cassette was fixed in the mouth with the aid of two "saddles" filled with thermoplastic material (Tenax wax or Kerr compound). The first adjustment of the film holder was carried out on the cast. The "saddles" were filled with heated material and pressed up against the teeth of the lateral parts of the maxillary cast or in the case of missing teeth against the edentulous alveolar process. When the material had hardened the impression of the teeth or alveolar process served to ensure that the apparatus took up the same position in the mouth as on the cast. The film-holder is articulated and to a large extent adjustable independently of whatever position the saddles happen to be in. In the front wall of the film-holder is a tube. When the film is to be put in parallel to the bisecting plane a short metal rod is inserted, to the front end of which is soldered a thin metal plate which, whatever its position, is always parallel to the plane of the film-holder (fig. 12). The metal plate is then adjusted so that

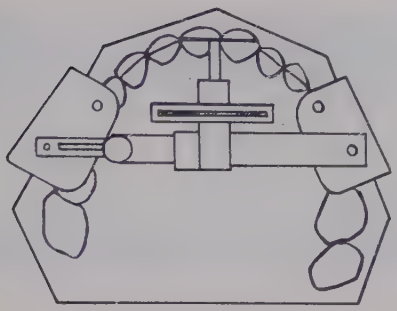


*Fig. 12. Apparatus for adjustment of x-ray film parallel to the bisecting plane of the tooth. The apparatus is fixed on the model with the aid of two saddles filled with thermoplastic material.*

it will, on sighting towards the edge of the tooth, form a direct continuation of the bisecting plane. The length of the rod is such that the centre of the film-pack will lie 2 cm from the bisecting plane. The film-holder is fixed in that position by tightening the screws and it is then transferred to the mouth. The subject holds the apparatus in position with light finger pressure on both sides.

After a final check in the mouth that the adjustment is correct, the rod is removed from the tube and another longer metal rod inserted. This is bent at right-angles at its free end and serves to keep the cone tip at exactly 13 cm from the centre of the film pack (fig. 13). Further,

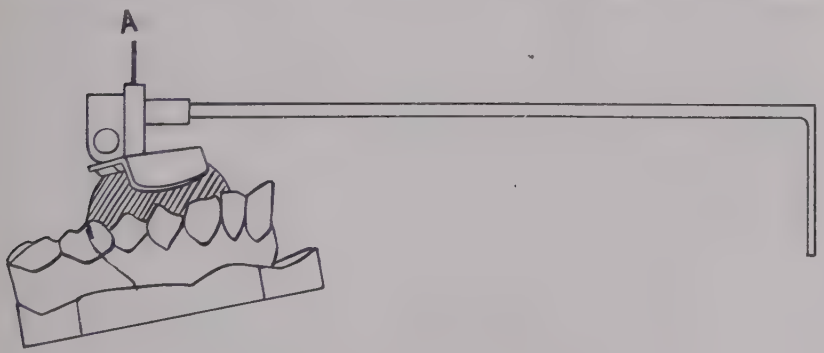



*Fig. 13. The same apparatus as illustrated in Fig. 12, seen from the side with the longer metal rod inserted. It is used in the adjustment of the x-ray cone. A = x-ray film.*

*Fig. 14. Schematic diagram of x-ray exposure with standard axis, proximal measuring points on the enamel margin and alveolar bone margin and normals from these points to the standard axis drawn in.*

it aids in the direction of the central ray, since the central axis of the cone can be sighted along the axis of the metal rod. When the cone has been locked it is moved parallel somewhat, in relation to the adjusting rod, so that the central ray strikes the desired place on the tooth.

After the usual dark-room processing of the film the measurements were carried out on it. As a basis for measurement a line was used which divided the crown of the tooth longitudinally into two halves. There was thus on the x-ray film a standard axis which corresponded to the axis along which the measurements were made on the cast. When constructing the axis on the film it was of great help that the pulp chamber, which most often lies at the centre of the tooth, could be observed. Those distances which were to be measured — the proximal enamel margin on both sides and the interdental septum margin — were marked out on the film with pin pricks, and from these, normals were dropped to the standard axis (fig. 14). In analogy with the conditions on the cast, measurement was then performed of the distance from the points of intersection of the axis and the incisal edge. The measurements were carried out with a slideguage to an accuracy of about 0.1 mm.

A question which arose in connection with these measurements was whether the terminal point of the tapering edge which appears along the sides of the crown on the film and which is caused by the enamel's greater imperviousness to x-rays really corresponds to the most incisally situated proximal enamel margin. To study this condition a number of extracted teeth were bored and filled with an x-ray con-

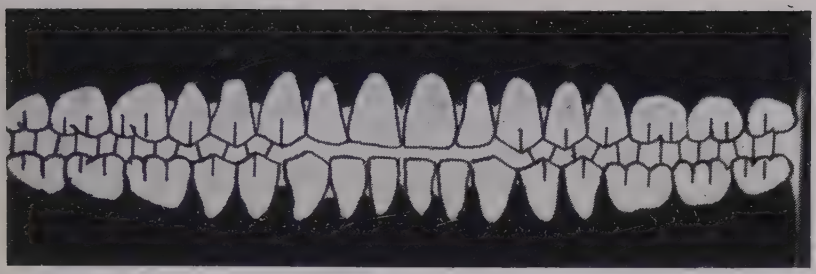


*Fig. 15. Calculation of the occlusion points in the ideal bite, according to Dahlberg (1942).*

trasting material. In some of them the filling was laid in the cement just apically of the cementoenamel junction and in the others in the enamel so that the apical limit of the filling corresponded exactly to the cementoenamel junction. The teeth were then x-rayed by the above technique and it appeared from the film that the fillings lay in the same relation to the enamel margin as on the tooth.

In the investigation it seemed desirable to estimate the *efficiency of the bite* in some way. This does not depend only on the condition and the number of the teeth but primarily on the extent to which the upper and lower antagonistic teeth occlude. The fewer the occluding antagonists the greater the a priori chance that their periodontiums will be over-stressed with consequent periodontal injury. A convenient method for ascertaining the efficiency of the bite is that reported by *B. Dahlberg* (1942) which comprises a points evaluation. He supposes the chewing surfaces of the teeth divided into sections. The rows of teeth are inspected in the position of central occlusion and the contacts between sections in the upper and lower jaws counted. A single contact counts as one point. The illustration (fig. 15) explains the points count for an ideal set of teeth. The molars, excluding the upper thirds, are divided into three sections, the upper thirds, the bicuspids and upper canines into two sections. The other teeth are evaluated at one point each.

The points count has been performed for the grinders (molars and bicuspids) separately on both sides and the anterior region.

The depth of the gingival pockets was measured intraorally with a metal probe, ½ mm in diameter (fig. 16). The probe was calibrated in half-millimetres and, to facilitate reading, every fifth graduation

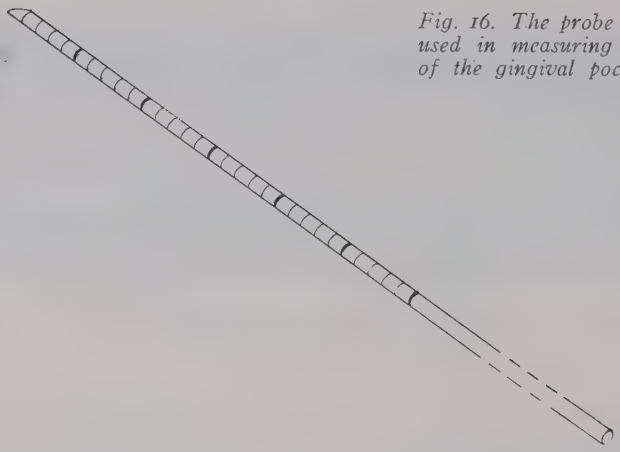


*Fig. 16. The probe (enlarged) used in measuring the depth of the gingival pocket.*

was marked in colour. So that the probe should slip more easily into the pocket its lower end was obliquely ground on one side. Measurements were made at the same points round the periphery of the tooth as in the determination of the position of the gingival margin and thus, corresponding to the middle of the anatomic labial and lingual surfaces and as near the contact points (surfaces) proximally as possible (mesiolabially, distolabially, mesiolingually and distolingually). When measuring, the probe was held, as far as was practicable, parallel to the standard axis of the crown. To this end an apparatus was at first used. It proved, however, that in order to overcome friction between the probe and the tube on the apparatus which guided the probe, a comparatively large pressure had to be used to lower the probe into the pocket. The base of the gingival pocket consists of soft tissue, so that there is a risk of pressing in the tip of the probe and thus damaging the base of the pocket, whilst there is also the chance of recording too high a value for the depth. It was therefore considered better to manipulate the probe with the hand, when the pressure could then be more easily moderated. The probe was inserted along the surface of the root until the typical elastic resistance was felt. Sometimes it happened that the probe was caught up on calculus, cementum-hyperplasia, etc. The firm unyielding resistance offered by these to the insertion of the probe cannot be confused with the base of the pocket. Another source of error is that, during measurement, the probe sometimes, on account of the vaulting of the tooth surface, forms an angle with the standard axis of the crown. When measuring

with the apparatus mentioned above, this angle could be determined directly and it was found that it was rarely as much as 15°. If one assumes the actual depth of a gingival pocket to be 2 mm, this will, with an inclination of the probe of 15°, give a measured depth of $2/\cos 15° = 2.071$ mm. If the pocket is 10 mm the measured value is 10.353 mm. In the great majority of cases the angle is less, and the error will consequently be smaller. An error of this magnitude is of very little importance in the method used here.

Dental fillings and cavities resulting from carious attack of the upper incisors were noted with respect to the particular surfaces involved and to the filling material. The investigation was carried out with probe and mirror in good light and the results were checked on the x-ray film.

To get some idea of the oral hygiene of the various subjects they were questioned on the frequency with which they used the tooth brush. They were divided into groups according to whether the reply was "daily", "irregular" or "never". Information of this type must of course be treated with reserve. For this reason an observation was made of the extent to which the crown exhibited materia alba. An assertion of daily brushing could be more easily accepted if the deposits were absent.

All cases of the presence of calculus on the teeth examined were noted. The examination was performed by means of inspections, probing of the gingival pockets and study of the x-ray films.

Other deviations from the normal of an outstanding nature were recorded; with regard to position of the teeth, for example. None of the subjects had — according to their own statements — undergone treatment for periodontal diseases.

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With regard to statistical methods, reference is made to the current textbooks, in particular that of *Dahlberg* (1940). It might be mentioned that the mean error was calculated from the formula

$$\varepsilon_{(M)} = \frac{\sqrt{\Sigma a^2}}{n}$$

where a = deviation from the arithmetic mean of a single observation

and n = the number of observations

*Sheppard*'s correction was made where necessary.

## Errors of measurement

Double determinations were performed to establish a measure of the accuracy of the methods used in this work. The results are given in Tables 4—9.

In order to compare the palatinal and labial values, in diastemas measurements of the distance between the same proximal measuring points on the gingival margin and the centre of the incisal edge were made from both sides (Table 4). These recorded values were the distances projected on to the standard axis.

To examine the manner in which the impression compound pressed aside the gingival margin on taking the impression, the direct distance from the gingival margin to the mid-point of the incisal edge was determined with a slide guage, measurements being taken both on the cast and intra-orally (Table 8). The measurements were taken mid-labially because it is here that the gingival margin is most easily displaced.

In Table 9 details are given of the error in measurement of greater depths of pocket (over 3 mm) so as to be able to compare them with those of more normal pockets.

The standard error of a single determination ($\sigma_i$) is always calculated from the formula $\sqrt{\frac{\Sigma d^2}{2n}}$, where d is the difference between the two values of the double determination, M is their arithmetic mean and n is the number of double determinations.

If the units of the scale are too large, too many zero differences are obtained. It is then possible, according to Professor *G. Dahlberg,* to calculate the maximum error of measurement by giving the zero differences the value of one scale unit. Such calculations were performed for safety's sake but except in measurements of pocket depth it appeared that differences between these maximum values and the errors of measurement calculated in the normal way showed up in but a few cases, and where then very small. In measuring the pocket depth the maximum error differed considerably from that calculated in the ordinary way.

*Table 4. The error (in mm) in measuring from labial and palatinal sides the same distance (projected on to the standard axis) between the proximal gingival margin and the incisal edge (mid-point) in the case of diastema*

(Accuracy of 0.01 mm)

| No. of double determinations | M (mm) | $\sigma_i$ | $\sigma_i$ as percentage of M |
|---|---|---|---|
| 20 | 6.04 | ± 0.14 | 2.33 % |

*Table 5. The error (in mm) in measuring the distance from gingival margin to incisal edge (mid-point) (projected on to the standard axis) on casts made on two different occasions*

(Accuracy of 0.01 mm)

| Measured | No. of double determinations | M (mm) | $\sigma_i$ | $\sigma_i$ as percentage of M |
|---|---|---|---|---|
| mid-labially | 25 | 9.10 | ± 0.14 | 1.53 |
| mesiolabially | 25 | 5.62 | ± 0.11 | 1.92 |
| distolabially | 25 | 6.37 | ± 0.11 | 1.66 |
| mid-lingually | 25 | 9.00 | ± 0.16 | 1.77 |

*Table 6. The minimum and maximum error (in mm) in measuring the object exposed on x-ray film on two different occasions*

(Accuracy of 0.1 mm)

| Measured distance | No. of double determinations | M (mm) | $\sigma_i$ | $\sigma_i$ as percentage of M |
|---|---|---|---|---|
| mesial enamel margin to incisal edge (mid-point) | 23 | 6.98 | ± 0.11—0.12 | 1.61—1.72 |
| distal enamel margin to incisal edge (mid-point) | 17 | 7.51 | ± 0.09—0.10 | 1.13—1.27 |
| mesial alveolar margin to incisal edge (mid-point) | 25 | 10.17 | ± 0.15 | 1.49 |
| distal alveolar margin to incisal edge (mid-point) | 22 | 10.92 | ± 0.11—0.12 | 1.03—1.07 |

*Table 7. Error (in degrees) in determination of the mid-point angle between the two measuring points on the gingival margin Performed on the same cast on two different occasions*

(Accuracy of 1°) (Complete circle 360°)

| Position of measuring point | No. of double measurements | M(°) | $\sigma_i$ | $\sigma_i$ as percentage of M |
|---|---|---|---|---|
| mid-lingual-mesiolabial | 25 | 112.7 | 2.82 | 2.50 |
| mid-lingual-distolabial | 25 | 109.8 | 3.83 | 3.48 |

*Table 8. The error in measurement (in mm) of the direct distance gingival margin — incisal edge (mid-point) on cast and intra-orally*

(Accuracy of 0.1 mm)

| No. of double determinations | M (mm) | $\sigma_i$ | $\sigma_i$ as percentage of M |
|---|---|---|---|
| 20 | 9.94 | 0.12 | 1.21 |

*Table 9. The error of measurement (in mm) in measuring depth of gingival pocket* (Accuracy of 0.5 mm)

| Measuring point | No. of double measurements | M (mm) | $\sigma_i$ | $\sigma_i$ as percentage of M |
|---|---|---|---|---|
| mid-labial | 25 | 1.07 | 0.20—0.35 | 18.69—32.71 |
| distolabial | 25 | 1.72 | 0.25—0.37 | 14.53—21.51 |
| mesiolabial | 25 | 1.82 | 0.23—0.35 | 12.64—19.23 |
| mid-lingual | 25 | 1.00 | 0.27—0.37 | 27.00—37.00 |
| proximal pockets with depth over 3 mm | 25 | 4.15 | 0.28—0.39 | 6.75— 9.40 |

## CHAPTER IV

# Material

The material on which the investigation was based consisted of two age groups. All the subjects were males.

1. The younger group comprised students at the Royal School of Dentistry in Stockholm. The number of people examined was 101. Their ages were between 20 and 35 years with 24.3 years as the median and 22.7 and 25.8 the quartiles.

2. The older group was made up partly of people from the Home for Aged People in Stockholm and partly from persons replying to announcements in the Stockholm press. The total number examined in this group was 102, between the ages 60 and 83 years. The median was 72.0 and the quartiles 68.8 and 75.3 years.

The following points should be noticed with regard to the material examined. The younger group, recruited from the Dental College, had probably better tended teeth than would be found in a group of arbitrarily chosen people of the same age. In relation to a group of much higher average age, a younger group would always have dentitions in better state. Regular dental care and oral hygiene are quite recent features of the national life. It proved impossible, however, to have at one's disposal a suitably large number of younger persons outside the Dental College for so comprehensive and time consuming an investigation as this.

Of the older material it may be said that it was chosen so as to comprise persons with more resistant teeth and periodontia than the average. Many people of that age have already lost all their teeth.

The people examined were asked if they had undergone gingival treatment or whether the upper incisors had been ground by any artificial means. No such people were found. Neither were there cases with upper prostheses.

No selection of the subjects was made other than that those with no remaining upper incisors were excluded. No attempt was made to obtain bites with most favourable occlusal conditions. It appears now and again in the literature that investigations have been made on such material in order to have "physiological" conditions. In the present work, however, the author has, instead, sought to create a picture from average material of older people.

From the social point of view the examined persons from the Dental College should probably be assigned to Social Group 2. Of the older subjects, the 21 living at the Home for Aged Persons belong to Group 3, and the other 81 a mixture of Group 2 with occasional ones from Group 3.

The investigation was restricted to the incisors of the upper jaw because these teeth are easily accessible for examination and installation of apparatus. It would of course have been desirable for the whole dentition to be examined in the same way, but that would have involved an inordinate amount of work so that, faced with the choice of making a less thorough examination of the whole dentition or a closer study of a section of it, the latter course was chosen.

## CHAPTER V

# The condition of the teeth. Oral hygiene

The periodontium provides the means of holding the teeth firmly in position. Changes which concern the teeth themselves would therefore be expected to affect the periodontium also. In an examination of the state of the periodontium the condition of the teeth should therefore be observed as well. In the present investigation the occlusal relationship was noted and a complete clinical examination of the upper incisors carried out, attention being paid to injuries resulting in the loss of the teeth or crowns, to fillings, untreated carious defects, crowding and diastemas.

The efficiency of the dentition depends on many different factors. One of these is the occlusal relationship between the jaws and this is determined by the method due to *B. Dahlberg* (1942). The tables given below indicate just what one would expect; i. e. that the occlusion of the younger people was considerably better than that of the older, the difference being statistically significant. The average of the occlusion points for the older group amounted to only 57 % of the younger.

*Table 10. Total No. of occlusion points*

| | No. | Occlusion points $M \pm \varepsilon_M$ | $\sigma$ |
|---|---|---|---|
| Younger group | 101 | 23.55 ± 0.52 | ± 5.23 |
| Older group | 102 | 13.45 ± 0.69 | ± 7.00 |

Each upper incisor in general corresponds to two antagonist teeth in the lower jaw. This was always true for the younger group. In the older group, on the other hand, there were occasions when one or more of the antagonists were extracted or so badly decayed that occlusal contact was impossible. Thus, there were 12 laterals and 19

*Table 11. Distribution of occlusion points of molars and bicuspids for each lateral half of the jaws (older group)*

| Right side \ Left side | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 points |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 11 | 1 | 2 | | 2 | | | | | | | | | |
| 1 | 5 | 1 | 1 | 1 | 1 | 1 | | | 1 | | | | | |
| 2 | 1 | 3 | 1 | 2 | 1 | 2 | 1 | | | | | | | |
| 3 | | | 2 | 3 | 1 | 1 | 1 | | 1 | | | | | |
| 4 | | 1 | 1 | 3 | 3 | 2 | 3 | | | 2 | | | | |
| 5 | | | 2 | | 1 | 3 | 1 | | | | 1 | | | |
| 6 | 1 | | | 1 | 3 | | 1 | 1 | | | 1 | | | |
| 7 | | | | | | | 1 | 3 | 1 | | | 1 | | |
| 8 | | | | | | | 1 | | | | | | | |
| 9 | | | | 2 | | | | | | | | | | |
| 10 | | | 1 | | | | | 2 | 2 | | 7 | 1 | | |
| 11 | | | | | | | | 1 | | | | | | |
| 12 | | | | | | | | | | | | | | |
| 13 | | | | | | | 1 | | | | | | | |

medials with only one antagonist each, while 3 laterals and 10 medials had none at all.

The teeth which are normally the most important in mastication are the molars and the bicuspids (the grinders). The distribution of the grinder points of the two groups is given in Tables 11 and 12.

Serious injury to the teeth often results in their loss. It should be noted in this connection that a tooth which is missing in the dental arch need not necessarily have been lost post-natally. It may lie retained in the jaw or may never have formed at all. This, however, is a comparatively rare occurrence as far as the upper incisor teeth

*Table 12. Distribution of occlusion points of molars and bicuspids for each lateral half of the jaws (younger group)*

Left side

| Right side points | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 points |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 1 | | | | | | | | | | | | |
| 1 | | | 1 | | | | | | | | | | | |
| 2 | | | | 1 | | | | | | | | | | |
| 3 | | | 1 | | | | | | | | | | | |
| 4 | | | | | 1 | | | | | 1 | | | | |
| 5 | | | | | 3 | 1 | | | | | | | | |
| 6 | | | | | | | | 2 | 2 | | 3 | | | |
| 7 | | | | | | | | 1 | 1 | 2 | 2 | | | 1 |
| 8 | | | | | | 1 | | 3 | | 4 | | | | |
| 9 | | | | | | 1 | 1 | 1 | 3 | | 1 | | | |
| 10 | | | | | | | 1 | 6 | 2 | 4 | 24 | | | 2 |
| 11 | | | | | | 1 | | | | 1 | 4 | 3 | | |
| 12 | | | | | | | | | | | | 1 | 1 | 1 |
| 13 | | | | | | | | | | 1 | 3 | 2 | 2 | 3 |

are concerned and need hardly be taken into consideration in an examination such as this. In the younger group, for example, there was not a single incisor among 101 subjects which had not formed and erupted.

In the older group, radiography did not expose any retained incisor teeth. According to *Dolder* (1936) the chance that a lateral incisor does not form is 0.4 % (10,000 cases examined). In his investigation all the upper medials were formed.

In addition to the loss of a tooth, the total carious destruction of the crown or its substitution by an artificial crown has been reckoned as serious dental defect.

In the younger group all the incisor teeth were present with the exception of two which were extracted. In both cases it was the 2+. 9 subjects had artificial crowns, two of them with two crowns each.

In the older group there was a considerable number of extracted teeth.

*Table 13. Artificial crowns*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Younger group | Tooth | +2 | +1 | 1+ | 2+ | laterals | 5 |
| | Number | 3 | 4 | 2 | 2 | medials | 6 |
| Older group | Tooth | +2 | +1 | 1+ | 2+ | laterals | 4 |
| | Number | 1 | — | — | 3 | medials | 0 |

Of those examined, 20 persons had one or more upper incisors missing. Of these subjects 6 persons had two missing teeth and the others had one.

*Table 14. Missing teeth*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Younger group | Tooth | +2 | +1 | 1+ | 2+ | laterals | 2 |
| | Number | — | — | — | 2 | medials | 0 |
| Older group | Tooth | +2 | +1 | 1+ | 2+ | laterals | 18 |
| | Number | 11 | 3 | 5 | 7 | medials | 8 |

4 persons had artificial crowns (Table 13). Decayed crowns not substituted with crown teeth were found in the case of 12 people, 3 of them having 2 destroyed upper incisors each (Table 15). It is interesting to note that the laterals showed considerably more evidence of severe injury than the medials. Table 16 shows that the difference is statistically significant. No corresponding difference is to be observed among the younger people.

*Table 15. Decayed dental crowns of the older group*

| | | | | | | |
|---|---|---|---|---|---|---|
| Tooth | +2 | +1 | 1+ | 2+ | laterals | 12 |
| Number | 5 | 1 | 2 | 7 | medials | 3 |

*Table 16. The number of severely damaged teeth*

Missing teeth + artificial crowns + decayed crowns

| | | |
|---|---|---|
| Younger group | laterals | 2+5+ 0 = 7 |
| | medials | 0+6+ 0 = 6 |
| Older group | laterals | 18+4+12 = 34 |
| | medials | 8+0+ 3 = 11 |

The difference between the numbers of severely damaged laterals and medials in the older group is 11.28 ± 3.05 %.

Before giving an account of fillings and teeth which were in various degrees destroyed by caries, it is desirable to discuss briefly the purpose of this record.

In Sweden the old *Bödecker* caries index (1931) is used, which aims at giving the number of dental surfaces — with certain restrictions — which have suffered carious attack. By his system, however, surfaces which are in certain respects unsuitable are included, and this may result in an erroneous valuation of the carious state if a caries index of the dentition is required. On this account the lingual surfaces and all four thirds were disregarded throughout so that the number of examined surfaces was exactly 100, instead of the full 148 (*Westin* and collaborators, 1943).

It must be pointed out that, as *B. Dahlberg* (1951) holds, it is necessary from the theoretical point of view to know how many points of carious attack exist. Further, it is required to know the extent of these carious areas. It is clear that, from these points of view, the method for indicating the number of affected surfaces is quite inadequate. For example, if two surfaces are affected it may be due to two quite separate carious attacks, but on the other hand it may be that an attack on one side spreads over to another and thus represents a single attack of large extent. Such disparities cannot be discerned from the statistics of attacked surfaces. Even if it is clear from the theoretical point of view that the system of attacked surfaces is deficient as a whole, still greater difficulties are met with in trying to compile a satisfactory statistical record. In the present case, the chief purpose is not however to register the carious defects but to record the extent to which the teeth are destroyed. It would perhaps have been more convenient, therefore, to have used the moulage system devised by *Dahlberg* and *Westin* (*Westin & Wold,* 1943), which permits a record of the extent of the caries. The essential thing in the present investigation, however, is the condition of the gingiva and other parts of the periodontium, the occurence of caries being of no great importance. I have been content therefore with the usual registration of all the surfaces, giving, thus, only an approximate representation of the condition of the teeth. The extracted incisor teeth in the two groups have been compared separately; they have not, for example, been included

in the caries index and placed in the same category as teeth with caries on three surfaces; this would be quite wrong since extracted teeth do not give rise to periodontal irritation, while three cavities might well do so. Dental crowns wholly destroyed by caries, and artificial crowns were placed on a level with teeth with caries or fillings on three surfaces so that over-valuation should not occur. To calculate the extent of the restorative work on the teeth the following procedure was followed. Each of the four surfaces of a filled tooth was allotted one point.

The total number of upper incisor fillings per subject in the older age group is 1.46 ± 0.24 points and in the younger group 4.57 ± 0.35 points. The number of filled dental surfaces in the younger group appreciably exceeds that of the older group and the difference is statistically significant. The older group however has a smaller number of teeth and this might conceivably influence the result. Inspecting the filling points for each tooth (Table 17) it appears that the character of the difference and the statistical significance are well established. The older persons have on the average a lower number of fillings per tooth than the younger.

*Table 17. Dental filling points for separate teeth*

Younger group:

| Tooth | Number | $M \pm \varepsilon_M$ filling points |
|---|---|---|
| +2 | 101 | 1.22 ± 0.11 |
| +1 | 101 | 1.15 ± 0.10 |
| 1+ | 101 | 1.13 ± 0.10 |
| 2+ | 99 | 1.10 ± 0.10 |

Older group:

| Tooth | Number | $M \pm \varepsilon_M$ filling points |
|---|---|---|
| +2 | 91 | 0.48 ± 0.09 |
| +1 | 99 | 0.29 ± 0.06 |
| 1+ | 97 | 0.30 ± 0.07 |
| 2+ | 95 | 0.50 ± 0.09 |

Difference between younger and older groups:

| Tooth | Difference (filling points) $D \pm \varepsilon_D$ |
|---|---|
| +2 | 0.74 ± 0.14 |
| +1 | 0.86 ± 0.12 |
| 1+ | 0.83 ± 0.12 |
| 2+ | 0.60 ± 0.13 |

If, within the respective groups, one compares the different teeth with respect to filling points it is found that there are only insignificant variations in the younger group, while in the older the laterals have a higher points value than the medials (Table 17).

It might be of interest to compare the filling materials which were used in the two groups (Table 18). Silicate cement fillings seem to be somewhat more common in the younger group, while for gold fillings the reverse was true.

*Table 18. Various filling materials as percentage of total number of points fillings in the upper incisor region*

| | Silicate cement | Amalgam | Gold | Artificial crowns |
|---|---|---|---|---|
| Younger group | 74.4 % | 15.8 % | 2.6 % | 7.2 % |
| Older group | 61.0 % | 16.1 % | 14.8 % | 8.1 % |

The number of untreated carious defects of the old people is noticeably greater than of the younger group. The average number of carious surfaces per person in the older group is 1.41 ± 0.20; for the younger group the figure is 0.19 ± 0.06 giving a difference of 1.22 ± 0.21 surface, which is thus significant.

It appears that, in this respect also, the laterals in the older group are not so well placed as the medials.

*Table 19. Number of untreated carious surfaces per tooth in the older group*

| Tooth | Number | $M \pm \varepsilon_M$ surface |
|---|---|---|
| +2 | 91 | 0.48 ± 0.09 |
| +1 | 99 | 0.26 ± 0.06 |
| 1+ | 97 | 0.27 ± 0.06 |
| 2+ | 95 | 0.51 ± 0.09 |

The lower resistance to carious attack which is displayed by the laterals has been observed before. For example, *Bornet* (1933) states that the laterals would have a lower resistance to caries. He does not offer any figures, however, in verification of this assertion. Just why the difference should make itself noticed after as long as 25 years seems strange. The laterals erupt into the oral cavity very early and should, one would think, display the higher caries frequency already at 25 years of age, after the comparatively low caries resistance of childhood years and youth. It is possible that the difference is only apparently a question of age. It is of course conceivable that in the more resistent dentition of the older material the laterals occupy an exceptional position. But it is also possible that behind the information available to the present author there is, in fact, concealed a difference for the younger group.

*Westin & Wold* (1943) have, in connection with the results of the investigation on 6 468 20-year-old males, compiled two lists in order of the caries incidence of the teeth. One list refers to missing and carious (or perfect) teeth; the other to missing, primary carious and filled surfaces (caries index). According to the first list, the upper medials appear immediately above the laterals in caries frequency. In the second list the position is reversed. These results are in agreement with the conditions obtaining for the present author's 25 year class.

Table 20 gives the total number of caries foci (that is, treated as well as untreated caries) of the older group.

*Table 20. The number of untreated carious surfaces + the number of points for dental fillings in the older group*

| Tooth | Number | $M \pm \varepsilon_M$ surface |
|---|---|---|
| +2 | 91 | 0.97 ± 0.13 |
| +1 | 99 | 0.56 ± 0.09 |
| 1+ | 97 | 0.57 ± 0.09 |
| 2+ | 95 | 1.00 ± 0.13 |

The differences between +2 & +1 and 1+ & 2+ are both probable.

The difference in respect of total caries between the older and younger groups is given for each tooth in Table 21. Here the number of untreated carious surfaces of the younger group has not been

included since these few cavities — 19 in number — have no great significance where the difference is concerned. The older group exhibits a smaller number of total carious attacks than the younger, the difference with regard to the medials being significant.

*Table 21. The difference between the younger and older groups with respect to the total number of carious attacks*

| Tooth | $M_{DIFF} \pm \varepsilon_{DIFF}$ surface |
|---|---|
| +2 | 0.25 ± 0.17 |
| +1 | 0.59 ± 0.13 |
| 1+ | 0.56 ± 0.13 |
| 2+ | 0.10 ± 0.16 |

Diastemas are considered to contribute to the occurrence of periodontal injuries on account of the food being pressed interdentally during mastication and thus damaging the gingiva (*Hischfeld,* 1930 et alii). In the present investigation it appeared that the percentage of subjects of the older group who have diastemas in the upper front is 65.7 ± 4.7 %, and in the younger group 55.4 ± 4.9 %. The difference is 10.3 ± 6.8 % and is thus not significant. The median for the single diastema is 0.80 mm in the older group and 0.55 mm in the younger. As mentioned previously it was necessary to leave the last diastema class open. It appears from the figures in this investigation that the number of people with diastemas was greater and the average diastema distance also greater in the older group, hardly a surprising conclusion considering the greater incidence of missing teeth in this group. Furthermore, diastemas appear among older people through several different causes; for example, the nature of the stress and the diminution in the original vertical dimension between the maxilla and mandible (*Euler,* 1940).

Since it is of importance to the analysis of the causal factors of periodontal injuries which appear below to be acquainted with any contingent covariation between diastema and occlusion points, a collection of this nature has been made for the two groups (Table 22). It seems conceivable that such a connection exists since a large number of lost teeth gives a small number of occlusion points and should at the same time increase the disposition towards diastema even in the anterior region.

*Table 22. Percentage of subjects with diastemas in the upper incisor region for different occlusion point totals*

| | Occlusion points | Number | Percentage of subjects with diastema | |
|---|---|---|---|---|
| Younger group | to 25 incl. | 53 | 52.8 ± 6.9 % | Diff. 5.5 ± 9.7 % |
| | from 26 incl. | 48 | 58.3 ± 6.8 % | |
| Older group | to 12 incl. | 49 | 85.7 ± 5.0 % | Diff. 38.5 ± 8.5 % |
| | from 13 incl. | 53 | 47.2 ± 6.9 % | |

The difference in the younger group is not significant but in the older group it is. A more thorough examination of the influence of the diastemas themselves on the periodontium (on the depth of the pocket and on the distance from the enamel margin to alveolar bone margin) has therefore nor been performed for the older group. Neither was it possible in the younger group, since the number of diastemas was to small to permit division into five groups according to their position in the dental arch.

The conditions of crowding in the upper incisor region of the jaw were measured. The number of subjects in the older group with crowding amounted to 42 of the 102 examined. The figures for the younger group are respectively 55 and 101. The difference is 13.3 ± 7.0 % and is not significant. The degrees of crowding for both groups appear in Table 23. The peculiar distribution in the case of the younger people is probably due to the fact that the mensuration methods did not permit great precision. Of the two maxima in the young group the first is probably due to the frequency of diastemas near the zero boundary which was not divided up but combined into one class. This maximum may be taken as apparent.

Among those subjects who exhibited crowding of the teeth are the more pronounced cases amongst the older persons. The difference amounts to 0.35 ± 0.19 mm and is thus not significant.

A possible covariation between crowding of the upper incisors and the total number of occlusion points has also been examined in the two groups (Table 24).

*Table 23. Degree of crowding in the upper incisor region (in mm)*

| Crowding in mm | Number of subjects Young | Old |
|---|---|---|
| 0.1—0.4 | 17 | 7 |
| 0.5—0.8 | 9 | 4 |
| 0.9—1.2 | 3 | 11 |
| 1.3—1.6 | 11 | 10 |
| 1.7—2.0 | 7 | 2 |
| 2.1—2.4 | 4 | 2 |
| 2.5—2.8 | 1 | 1 |
| 2.9—3.2 | 3 | 1 |
| 3.3—3.6 | — | 2 |
| 3.7—4.0 | — | — |
| 4.1—4.4 | — | — |
| 4.5—4.8 | — | 1 |
| 4.9—5.2 | — | — |
| 5.3—5.6 | — | — |
| 5.7—6.0 | — | — |
| 6.1—6.4 | — | — |
| 6.5—6.8 | — | — |
| 6.9—7.2 | — | — |
| 7.3—7.6 | — | 1 |
| | Total 55 | 42 |

*Table 24. Percentage of subjects with crowding in the upper incisor region for different numbers of occlusion points*

| | Occlusion points | Number | Percentage of subjects with crowding in upper incisor region | |
|---|---|---|---|---|
| Younger group | to 25 incl. | 53 | 49.1 ± 6.9 % | Diff. 11.3 ± 9.9 % |
| | from 26 incl. | 48 | 60.4 ± 7.1 % | |
| Older group | to 12 incl. | 49 | 22.4 ± 6.0 % | Diff. 36.1 ± 9.1 % |
| | from 13 incl. | 53 | 58.5 ± 6.8 % | |

In the younger age group there is no significant difference. In the older group the difference is significant. In the younger group the extent to which crowding and the occlusion points are connected (Table 25) was examined.

*Table 25. The degree of crowding (in mm) for different numbers of occlusion points*

| Occlusion points | Number | Crowding in mm $M \pm \varepsilon_M$ | |
|---|---|---|---|
| to 25 incl. | 53 | 1.00 ± 0.18 | Diff. 0.11 ± 0.23 mm |
| from 26 incl. | 48 | 0.89 ± 0.15 | |

There is a small non-significant difference. It is the opposite to the case in Table 24. In the treatment of the material which follows, regard probably need to be taken of any contingent connection between occlusion points and crowding in the younger group.

Table 26 shows that tartar is considerably more common among the older than the younger persons. The difference is statistically significant. Materia alba is also more prevalent (statistically significant) among the older people, certainly due in part to the less frequent use of the tooth brush. (*Hilming & Pedersen,* 1940, showed however in their investigations that materia alba was commoner among older persons in East Greenland. One would imagine there is no great attention devoted to brushing of the teeth in these parts of the world.) All in the younger group claimed to brush their teeth daily while only 53 out of 102 of the older group replied to this effect.

*Table 26. Calculus and materia alba*

| | Number examined | Percentage subjects with calculus |
|---|---|---|
| Older group | 102 | 86.3 ± 3.4 % |
| Younger group | 101 | 9.9 ± 3.0 % |
| | | **Percentage subjects with materia alba** |
| Older group | 102 | 42.6 ± 4.9 % |
| Younger group | 101 | 10.9 ± 3.1 % |

To an inquiry on brushing the teeth it might easily happen that false answers were given. For this reason in the older group a check was made, collecting data on brushing frequency and the presence of soft deposits. 65.3 ± 6.8 % of those who did not brush their teeth daily had soft deposits. The corresponding figures for those who did brush their teeth daily were 21.2 ± 5.7 %. The difference is 44.1 ± 8.9 % and is significant, thus tending to bear out the reliability of the replies to the questions.

The covariation between calculus and materia alba is treated in Table 27.

*Table 27. The percentage of subjects without materia alba (a) with calculus, (b) without calculus (older group)*

| | Number | Percentage subjects without materia alba |
|---|---|---|
| Calculus | 14 | 71.4 ± 12.1 |
| No calculus | 88 | 55.2 ± 5.3 |

The difference is 16.2 ± 13.2 %. Its direction might well evoke astonishment. It is not significant, exceeding the mean error by a negligle quantity.

## CHAPTER VI

# Gingival erythema and haemorrhage Loosening of the teeth

In the following, the term gingivitis denotes reddening of the marginal gingiva of the upper incisor region. The tendency towards haemorrhage can at the same time exist to a more or less pronounced extent. Sometimes it is possible to observe spontaneous bleeding from the gingiva but in general some slight contact is necessary before blood will flow. In this investigation it has been noted when and where bleeding occurred during the careful probing necessary to measure the depth of the pockets. Haemorrhage is generally caused when the probe touches a place in the pocket where the surface epithelial layer is damaged, but may also occur on too vigorous probing even when there is no diseased or damaged condition of the epithelial layer. In any case further signs of inflammation, e. g. erythema of the gingiva, will be looked for before accepting the bleeding as a pathological symptom. In the younger group, three cases were found where haemorrhage occurred at one place or another on probing without there being any evident reddening of the gingiva. In the older group there were 7 cases of bleeding from the gingival pocket without reddening. It is, of course, difficult to decide if these cases indicated inflammatory conditions or just injuries due to probing.

A common sign of inflammation of the gingiva is the reddening of the free gingival margin. It generally begins in a papilla and may then spread along the margin. In order to assess the extent of the inflammation in this direction a points system has been used. Inflamed gingiva around the whole tooth was evaluated as six points: one point each for mesio-, centro- and disto-labial and mesio-, centro- and disto-palatinal position.

In the case of inflammation extending over a greater region than corresponds to one tooth, the count used to obviate over-valuation of papillitis entailed a reduction of the number of points so that each side of a papilla (palatinally or orally) was valued as one point. In reddening along the whole gingival margin of the four teeth considered, the sum of the points was consequently 18 instead of 24, reckoning 6 points for each tooth.

The percentage of subjects with erythema and haemorrhage of the gingiva appear in Table 28 below.

*Table 28. Gingival erythema and haemorrhage in the upper incisor region*

| | Number | Haemorrhage only | Erythema only | Both haemorrhage and erythema |
|---|---|---|---|---|
| Younger | 101 | 2.97 % | 13.86 % | 18.81 % |
| Older | 102 | 6.86 % | 19.61 % | 54.90 % |

For the sake of certainty, only the two last sub-groups in Table 28 are accepted as being effected by gingivitis, the difference between younger and older being 41.8 ± 6.4 %. This is significant, and indicates that the older group has more cases of gingivitis than the younger.

*Table 29. The extent of gingival erythema in the upper incisor region of subjects with gingivitis*

| | Number | Erythema points $M \pm \varepsilon_M$ |
|---|---|---|
| Younger | 33 | 7.21 ± 0.80 |
| Older | 76 | 10.80 ± 0.63 |

The difference is 3.59 ± 1.04 points and is significant. From Table 29 it appears that in cases of gingivitis its extent along the gingival margin is greater in the older group. In this group gingivitis is thus more frequent and more extensive than among the younger people.

*Table 30. Extent of gingival erythema labially and palatinally in the upper incisor region of subjects with gingivitis*

| | Number | Erythema points labially $M \pm \varepsilon_M$ | Erythema points palatinally $M \pm \varepsilon_M$ |
|---|---|---|---|
| Younger | 33 | 4.30 ± 0.46 | 2.91 ± 0.64 |
| Older | 76 | 5.42 ± 0.38 | 5.38 ± 0.42 |

The difference labio-palatinally in the younger group is 1.39 ± 0.79 points
„ „ „ „ „ „ older „ „ 0.04 ± 0.57 „

The extent of the labial erythema exceeds the palatinal in the younger group (Table 30), but the difference is not even statistically probable. In the older group there is no difference. The results agree on the whole with the experience from clinical work.

*Table 31. Extent of gingival erythema around each separate tooth of persons with gingivitis*

| Tooth | Younger Number | Younger Erythema points $M \pm \varepsilon_M$ | Older Number | Older Erythema points $M \pm \varepsilon_M$ |
|---|---|---|---|---|
| +2 | 33 | 2.03 ± 0.36 | 67 | 3.45 ± 0.30 |
| +1 | 33 | 2.03 ± 0.36 | 73 | 3.55 ± 0.25 |
| 1+ | 33 | 2.42 ± 0.35 | 72 | 3.92 ± 0.24 |
| 2+ | 33 | 2.73 ± 0.38 | 70 | 4.06 ± 0.26 |

In Table 31, which shows the extent of the gingival erythema around each tooth, the number of points does not differ so much, but with both young and older people the number tends to be larger for the right side of the mouth. The difference between the two extremes (+2 and 2+) is, in the younger series, 0.70 ± 0.52 points and in the older series 0.61 ± 0.41 points. Thus, in no case was it significant or probable. If the differences should appear real it is conceivable that they have some connection with brushing of the teeth which, by right-handed persons, can be better performed on the left side.

How oral hygiene such as brushing influences the incidence of gingivitis was investigated among the older people (Table 32).

*Table 32. Average number of erythema points in the upper incisor region for different frequencies of brushing (older group)*

| | Number | Total erythema points in the upper incisor region $M \pm \varepsilon_M$ |
|---|---|---|
| Daily brushing | 53 | 5.68 ± 0.80 |
| No daily brushing | 49 | 10.61 ± 0.95 |

The difference between the two groups in Table 32 is 4.93 ± 1.24 points. This is significant and means that those who brushed their teeth daily have on the average less extensive marginal erythema. In this fact the author is in full aggreement with *Westin* and *Wold* (1943).

It would be possible to examine the effect on the gingiva of other factors such as caries, dental fillings and crowding, but one must first be certain that these factors are not concomitant. One would think that persons with better economic status and social position are more interested in brushing their teeth than the others. It is also possible that such people more readily seek treatment for caries and therefore have fewer defects but many fillings; they will thus have a smaller number of missing teeth, fewer diastemas and a consequent higher number of occlusion points. This would imply that there is no direct relationship between the quality of oral hygiene and the number of fillings, but that this correlation is dependent on the fact that both factors are connected with the economic factors.

In order to analyse these factors, tables have been compiled (Tables 33—37) relating them to the brushing of the teeth.

*Table 33. Number of filled surfaces in the upper incisor region for different frequencies of brushing (older group)*

| | Number | Filled incisor surfaces $M \pm \varepsilon_M$ |
|---|---|---|
| Daily brushing | 53 | 2.15 ± 0.39 |
| No daily brushing | 49 | 0.71 ± 0.20 |

The difference is 1.44 ± 0.44 surfaces and is significant. Those who practise oral hygiene diligently have thus more dental fillings than the other group.

*Table 34. Number of carious surfaces in the upper incisor region for different frequencies of brushing (older group)*

| | Number | Carious incisor surfaces $M \pm \varepsilon_M$ |
|---|---|---|
| Daily brushing | 53 | 0.74 ± 0.19 |
| No daily brushing | 49 | 2.14 ± 0.35 |

The difference is 1.40 ± 0.40 surfaces and is significant. Poor oral hygiene is followed by a larger number of cavities.

*Table 35. Total of occlusion points for different frequencies of brushing (older group)*

| | Number | Total occlusion points $M \pm \varepsilon_M$ |
|---|---|---|
| Daily brushing | 53 | 15.98 ± 0.92 |
| No daily brushing | 49 | 10.71 ± 0.90 |

The difference is 5.27 ± 1.29 points and is significant.

*Table 36. Percentage of subjects with diastema in the upper incisor region for different frequencies of brushing (older group)*

| | Percentage of subjects with incisor diastemas |
|---|---|
| Daily brushing | 45.3 ± 6.8 % |
| No daily brushing | 87.8 ± 4.7 % |

The difference is 42.5 ± 8.3 % and is significant. The results in Tables 35 and 36 are intimately connected. Any loss of teeth will result in both decrease of occlusion points and increase of diastemas.

*Table 37. Percentage of subjects with crowding in the upper incisor region for different frequencies of brushing (older group)*

| | Percentage with crowding |
|---|---|
| Daily brushing | 52.8 ± 6.9 % |
| No daily brushing | 28.6 ± 6.5 % |

The difference is 24.2 ± 9.5 % and is probable.

As was expected, dental fillings, carious defects, occlusion points and diastemas all exhibited co-variation with the brushing factor. Even crowding of the teeth is probably indirectly connected with the frequency of brushing. Good oral hygiene (and economic status) has clearly contributed to the conservation of crowding of the teeth. It is clear that one should be cautious when deciding whether any particular factor is of significance to the state of the periodontium.

Failure to observe this source of error can easily lead to fallacious conclusions. Such a statement as that given above in Chapter I (*Shay & Smart,* 1945) saying that an increase in the percentage of healthy gingiva accompanies an increasing number of fillings, cannot be credited if it is supported only by an examination of a group of persons displaying the above-mentioned co-variations.

With regard to the older group it would perhaps be best only to divide it into two sub-groups with good and bad oral hygiene and to allow frequency of brushing to decide in which group the subject shall be placed. In certain cases, however, it should be possible to estimate the effect on the periodontium of individual factors other than brushing. In the younger of the examined groups — the dental students — oral hygiene and dental care are rather good and uniform, so that this group could be used for estimating the influence of single factors on the health of the periodontium.

*Table 38. Dental fillings and total erythema points in the upper incisor region*

| | Number | Erythema points $M \pm \varepsilon_M$ |
|---|---|---|
| Younger group with 4 or less filled incisor surfaces | 47 | 1.45 ± 0.53 |
| Younger group with 5 or more filled incisor surfaces | 54 | 3.15 ± 0.63 |
| The difference is 1.70 ± 0.82 points. | | |
| Older group without incisor fillings | 59 | 9.42 ± 0.88 |
| Older group with incisor fillings | 43 | 6.16 ± 0.95 |
| The difference is 3.26 ± 1.29 points and is probable. | | |

Table 38 shows the risk involved in evaluating the injurious effect of dental fillings on the periodontia of the older group. All evidence points to the fact that the estimate for the younger group — with their well-tended teeth — approaches nearer the truth.

*Table 39. Carious defects and total erythema points in the upper incisor region (older group)*

| | Number | Total erythema points $M \pm \varepsilon_M$ |
|---|---|---|
| Carious | 52 | 7.35 ± 0.98 |
| Non-carious | 50 | 8.78 ± 0.87 |

The difference is 1.43 ± 1.31 points.

In Table 39 the younger group is not included since the number of carious defects there was very small. The results for the older group do not tell us much.

*Table 40. Total occlusion points and number of erythema points in the upper incisor region*

| | Number | Erythema points $M \pm \varepsilon_M$ |
|---|---|---|
| Younger group with 26 or more occlusion points ..... | 48 | 3.02 ± 0.68 |
| Younger group with 25 or less occlusion points ..... | 53 | 1.75 ± 0.52 |
| Difference 1.27 ± 0.86 points. | | |
| Older group with 13 or more occlusion points ..... | 53 | 7.77 ± 0.94 |
| Older group with 12 or less occlusion points ..... | 49 | 8.35 ± 0.95 |
| Difference 0.58 ± 1.34 points. | | |

Table 40 shows that neither younger nor older groups give differences which are even probable, so that no conclusion can be drawn from the result.

*Table 41. Diastemas and total erythema points in the incisor region*

| | Number | Erythema points $M \pm \varepsilon_M$ |
|---|---|---|
| Younger group without diastema | 45 | 2.27 ± 0.61 |
| Younger group with diastema | 56 | 2.43 ± 0.59 |
| Difference 0.16 ± 0.85 points. | | |
| Older group without diastema | 35 | 6.20 ± 1.11 |
| Older group with diastema | 67 | 9.01 ± 0.81 |
| Difference 2.81 ± 1.38 points. | | |

The difference for both sections of the older group in Table 41 is just as one would expect from the relationship between oral hygiene and diastema.

*Table 42. Crowding and total erythema points in the upper incisor region*

| | Number | Erythema points $M \pm \varepsilon_M$ |
|---|---|---|
| Younger group without crowding | 46 | 2.28 ± 0.71 |
| Younger group with crowding | 55 | 2.42 ± 0.51 |
| Difference 0.14 ± 0.87 points. | | |
| Older group without crowding | 60 | 7.68 ± 0.84 |
| Older group with crowding | 42 | 8.57 ± 1.08 |
| Difference 0.89 ± 1.37 points. | | |

*Table 43. Calculus and total erythema points in the upper incisor region (older group)*

| | Number | Erythema points $M \pm \varepsilon_M$ |
|---|---|---|
| Without calculus | 14 | 2.29 ± 0.81 |
| With calculus | 88 | 8.97 ± 0.71 |

The difference is 6.68 ± 1.08 points and is significant.

In the last chapter a comparison was made between the incidence of calculus and the incidence of material alba. There was no evidence from the material for supposing the presence of calculus and materia alba are related. It seems probable therefore that the difference in Table 43 is correct and not just apparent, depending on the conditions of oral hygiene.

A symptom of disturbed periodontal health is the loosening of the teeth. The clinical investigation of this factor is the basis for Table 44.

*Table 44. The percentage of subjects with some teeth of the upper incisor region poorly fixed*

| | Number | Percentage of subjects with poorly fixed teeth |
|---|---|---|
| Younger | 101 | 0 |
| Older | 102 | $23.5 \pm 4.2$ % |

The difference is significant.

The method used here for investigating the firmness of the teeth is less accurate than many others. *Beyeler & Dreyfus* (1947) and *Mühlemann* (1950) each constructed an apparatus for careful measurement of the mobility of the teeth. To have followed such a technique as these authors describe would have complicated the investigation to an unwarranted extent, so that the present author has been content with a clinical assessment.

*Herulf*'s investigation (1950) of the incidence of gingivitis in the lower incisor region, from the male component of his dental student material, shows a somewhat higher value (55 %) than the present author's from the corresponding part in the upper jaw (33 %), possibly due to the fact that calculus occurs more often in the lower anterior region.

The average figures for the gingivitis incidence from various authors mentioned in the Survey of the Literature (Chap. I) display widely varying values. It is hardly possible to effect a comparison with the present author's figures since different parts of the mouth are concerned.

In common with most other opinions, it appeared that the incidence of gingivitis in this investigation was greater with increasing age. The co-variation gingivitis—calculus is thus clear from this material.

With regard to a contingent inter-relationship where opinions in the literature are not in agreement, the following results, are given for this investigation. The incidence of gingivitis showed no notable change in crowding of the teeth, untreated caries and diastemas. There was a certain tendency in one group with greater numbers of fillings towards a rise of incidence.

## CHAPTER VII

# The gingival pocket

The gingival pocket is a crevice-shaped space lying between the hard tissue of the tooth and the surrounding soft tissue. It issues at the free margin of the gingiva into the oral cavity. The base consists of the innermost soft part, the epithelial layer attached to the tooth. The question of the structure and condition of the gingival pocket is of great importance inasmuch as it may act as the site of origin of inflammatory processes, since the pocket provides a place of retention for food debris, desquamated epithelial cells, calculus deposits, bacteria, etc. Under pathological conditions the pocket might be deepened through the loosening of the soft layer from the dental surface, resulting in an apical movement of the pocket base. The deeper the pocket becomes the greater — under otherwise similar circumstances — the chance that it will act as the place of deposit of material that will promote inflammation. An important object of periodontal therapy is thus to remove such pathologically deepened pockets. Accordingly, there has been a great deal of discussion in the literature on the depth of these pockets. Difficulties have, however, been encountered in deciding which pockets should be considered as normal or physiologic. *James & Counsell* (1927) maintain that the very existance of a pocket is a pathologic phenomen. *Blumentritt* (1926) states that a pocket larger than 1.55 mm is always considered as pathologic. Others, again, (e. g. *Orban & Köhler,* 1924) have found in their investigations that pockets of considerable depth, 5 mm approximately, may be without pathologic changes.

If mean values obtained by measurement are considered it is found that the normal depth of the pocket generally lies under or near 1 mm. Higher values than 2 mm are not mentioned by any author.

In order to analyse the conditions according to the depth of pockets in the present author's material, the depth has ben examined on each of the upper incisors with a probe, where possible at each of six points on the periphery of the tooth, namely mid-labially (l) and mid-lingually (p), mesiolabially (ml) and mesiolingually (mp), distolabially (dl) and distolingually (dp). The technique is described in Chap. III.

There is some justification for regarding these methods of mensuration of the gingival pocket as inexact. An important source of error is, for example, that the base of the pocket composed of soft tissue can be depressed into the underlying tissue through pressure of the measuring instrument and that the values will therefore be too great.

The chance degree of uncertainty in the method may be determined by double measurements of the same pocket and this was done in a number of cases. The results are given in Chap. III. It might be further pointed out that the systematic errors cannot be computed since no comparative examinations with different subjects were performed. It is, however, self-evident that the greatest possible care was taken not to press on the base of the pocket in a manner which could give rise to such a systematic error.

Even if some degree of uncertainty is attached to the mensuration, the examination is of such importance that it cannot be omitted from a clinical examination of the periodontium if any claim to completeness is to be made.

Table 45 shows the mean values of the depths of the pockets of all the subjects of both groups. The mean depths in the younger and in practically the whole of the older group were found to be least mid-labially, then mid-lingually, while the deepest part of the pocket was the proximal. In the younger group the mean value varied between 0.84 and 1.90 mm and in the older group between 1.23 and 2.57 mm, as is seen also from the diagram in Fig. 17. The older group displayed a greater depth of pocket than the younger for all 24 sites, and the differences were statistically significant. The $\sigma$ values in the older group are considerably greater than in the younger due to the depth of the pocket in the former exhibiting a greater range af values. The $\sigma$ differences between older and younger groups were significant for all sites with the exception of three where they were probable.

A treatment was effected of the material in Table 45 by means of

*Table 45. Mean values of pockets (mm) (younger and older groups)*

| Tooth | Measured | Younger group No. | Younger group $M \pm \varepsilon_M$ | Younger group σ | Older group No. | Older group $M \pm \varepsilon_M$ | Older group σ | Difference $D \pm \varepsilon_D$ |
|---|---|---|---|---|---|---|---|---|
| +2 | distolab. | 101 | 1.75 ± 0.063 | 0.63 | 90 | 2.31 ± 0.118 | 1.12 | 0.56 ± 0.134 |
| +2 | midlab. | 101 | 0.84 ± 0.033 | 0.33 | 90 | 1.23 ± 0.063 | 0.60 | 0.39 ± 0.071 |
| +2 | mesiolab. | 101 | 1.89 ± 0.062 | 0.63 | 90 | 2.51 ± 0.090 | 0.85 | 0.62 ± 0.109 |
| +2 | mesioling. | 100 | 1.50 ± 0.048 | 0.48 | 86 | 2.20 ± 0.086 | 0.79 | 0.70 ± 0.098 |
| +2 | midling. | 100 | 1.12 ± 0.036 | 0.35 | 90 | 1.57 ± 0.071 | 0.68 | 0.45 ± 0.080 |
| +2 | distoling. | 101 | 1.46 ± 0.051 | 0.51 | 87 | 2.21 ± 0.102 | 0.95 | 0.75 ± 0.114 |
| +1 | distolab. | 101 | 1.77 ± 0.057 | 0.57 | 98 | 2.13 ± 0.075 | 0.74 | 0.36 ± 0.094 |
| +1 | midlab. | 101 | 0.93 ± 0.039 | 0.39 | 98 | 1.57 ± 0.086 | 0.85 | 0.64 ± 0.094 |
| +1 | mesiolab. | 101 | 1.83 ± 0.055 | 0.55 | 98 | 2.40 ± 0.101 | 1.00 | 0.57 ± 0.115 |
| +1 | mesioling. | 101 | 1.75 ± 0.053 | 0.53 | 97 | 2.30 ± 0.095 | 0.93 | 0.55 ± 0.109 |
| +1 | midling. | 101 | 1.09 ± 0.042 | 0.42 | 98 | 1.54 ± 0.082 | 0.81 | 0.45 ± 0.092 |
| +1 | distoling. | 100 | 1.49 ± 0.055 | 0.55 | 96 | 2.15 ± 0.087 | 0.85 | 0.66 ± 0.103 |
| 1+ | distolab. | 101 | 1.89 ± 0.055 | 0.55 | 97 | 2.48 ± 0.099 | 0.98 | 0.59 ± 0.113 |
| 1+ | midlab. | 101 | 0.91 ± 0.034 | 0.34 | 97 | 1.48 ± 0.069 | 0.68 | 0.57 ± 0.077 |
| 1+ | mesiolab. | 101 | 1.67 ± 0.051 | 0.51 | 97 | 2.21 ± 0.083 | 0.82 | 0.54 ± 0.097 |
| 1+ | mesioling. | 101 | 1.70 ± 0.054 | 0.55 | 95 | 2.26 ± 0.076 | 0.75 | 0.56 ± 0.093 |
| 1+ | midling. | 101 | 1.02 ± 0.037 | 0.37 | 97 | 1.63 ± 0.081 | 0.80 | 0.61 ± 0.089 |
| 1+ | distoling. | 100 | 1.51 ± 0.051 | 0.51 | 96 | 2.32 ± 0.090 | 0.88 | 0.81 ± 0.103 |
| 2+ | distolab. | 99 | 1.90 ± 0.060 | 0.60 | 91 | 2.57 ± 0.119 | 1.14 | 0.67 ± 0.133 |
| 2+ | midlab. | 99 | 0.85 ± 0.036 | 0.36 | 91 | 1.34 ± 0.068 | 0.65 | 0.49 ± 0.077 |
| 2+ | mesiolab. | 99 | 1.90 ± 0.064 | 0.64 | 91 | 2.46 ± 0.094 | 0.90 | 0.56 ± 0.114 |
| 2+ | mesioling. | 98 | 1.42 ± 0.063 | 0.62 | 90 | 2.21 ± 0.087 | 0.82 | 0.79 ± 0.107 |
| 2+ | midling. | 99 | 1.11 ± 0.045 | 0.45 | 91 | 1.57 ± 0.072 | 0.69 | 0.46 ± 0.085 |
| 2+ | distoling. | 99 | 1.50 ± 0.053 | 0.52 | 89 | 2.42 ± 0.101 | 0.95 | 0.92 ± 0.114 |

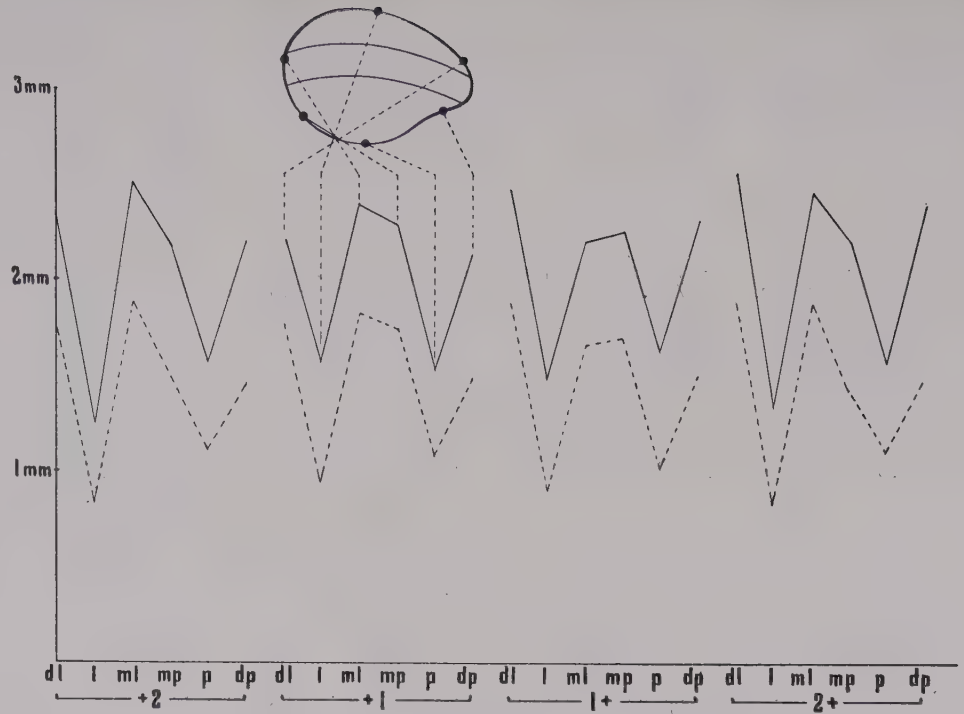


*Fig. 17. The depth of the gingival pocket. Older group = continuous line: younger group = broken line.*

the $\chi^2$ test when only one value — the mid-labial — was used per tooth, since different values of the depth round the same tooth are correlated. It was seen that close agreement was the rule between these two compared groups in respect of the relative variation of the four teeth in the different measurements. The probability of a poorer chance agreement is greater than 0.8. It is important to calculate $\chi^2$ because the single values can display no significant differences but a divergence may still exist and come to light on applying the $\chi^2$ test. This method is thus used if one wishes to compare several values with mean-errors. If one obtains some significant difference by comparing single values it is strictly speaking not necessary.

The question might arise as to whether the, on the average, deeper pockets of the older group have a pathologic explanation, as the number of gingivitis cases is considerably greater in this group. A collection of the mean values around teeth has thus been made for the two groups, in cases where no reddening of the gingiva in the immediate vicinity of the tooth was apparent (Table 46, Fig. 18).

It appears that the mean values of the pocket depths is still consistently greater in the older group. Only four differences concerning three teeth are significant with one of them probable. The reason for so few significant differences might be that the small number of teeth with gingivitis-free surrounding structure in the older group incurred a high mean error. The average value of the pocket depths varies in the younger group between 0.80 and 1.83 mm and in the older between 0.95 and 2.27 mm. The application of the $\chi^2$ test has shown the same close agreement between the groups as in the former case.

A further comparison was made in the two groups with respect to the depth of pockets around the teeth which indicated reddening of the immediate gingival tissue and around those which did not show any such colour change. It follows from this that, in all cases, the pockets in the case of gingivitis are deeper than when the gingiva appears normal. In the older group (Fig. 19) there are in this respect 13 significant and 4 probable differences. In the younger group (Fig. 20) there were 9 significant and 2 probable differences. Application of the $\chi^2$ test gave the same satisfactory agreement as previously.

The deepening of the pocket in the case of gingivitis might be thought to occur through swelling of the free gingival margin or through the apical displacement of the base of the pocket. It is often

*Table 46. Mean values of pockets (mm) without gingivitis (younger and older groups)*

| Tooth | Measured | Younger group No. | Younger group $M \pm \varepsilon_M$ | Older group No. | Older group $M \pm \varepsilon_M$ | Difference $D \pm \varepsilon_D$ |
|---|---|---|---|---|---|---|
| +2 | distolab. | 81 | 1.63 ± 0.066 | 23 | 1.95 ± 0.208 | 0.32 |
| +2 | midlab. | 81 | 0.82 ± 0.037 | 23 | 1.10 ± 0.124 | 0.28 |
| +2 | mesiolab. | 81 | 1.83 ± 0.070 | 23 | 2.10 ± 0.155 | 0.27 |
| +2 | mesioling. | 80 | 1.41 ± 0.048 | 21 | 1.80 ± 0.160 | 0.39 |
| +2 | midling. | 80 | 1.09 ± 0.040 | 23 | 1.21 ± 0.092 | 0.12 |
| +2 | distoling. | 81 | 1.39 ± 0.048 | 22 | 2.11 ± 0.211 | 0.72 ± 0.216 |
| +1 | distolab. | 80 | 1.67 ± 0.058 | 25 | 1.73 ± 0.134 | 0.06 |
| +1 | midlab. | 80 | 0.91 ± 0.044 | 25 | 1.07 ± 0.064 | 0.16 ± 0.078 |
| +1 | mesiolab. | 80 | 1.75 ± 0.054 | 25 | 1.89 ± 0.117 | 0.14 |
| +1 | mesioling. | 80 | 1.74 ± 0.058 | 24 | 1.92 ± 0.098 | 0.18 |
| +1 | midling. | 80 | 1.08 ± 0.044 | 25 | 1.25 ± 0.086 | 0.17 |
| +1 | distoling. | 79 | 1.39 ± 0.059 | 24 | 1.67 ± 0.130 | 0.28 |
| 1+ | distolab. | 75 | 1.75 ± 0.051 | 25 | 2.01 ± 0.116 | 0.26 |
| 1+ | midlab. | 75 | 0.90 ± 0.043 | 25 | 1.35 ± 0.076 | 0.45 ± 0.087 |
| 1+ | mesiolab. | 75 | 1.58 ± 0.047 | 25 | 1.77 ± 0.117 | 0.19 |
| 1+ | mesioling. | 75 | 1.63 ± 0.057 | 24 | 1.98 ± 0.113 | 0.35 ± 0.127 |
| 1+ | midling | 75 | 1.00 ± 0.041 | 25 | 1.15 ± 0.100 | 0.15 |
| 1+ | distoling. | 75 | 1.45 ± 0.058 | 25 | 1.77 ± 0.140 | 0.32 |
| 2+ | distolab. | 74 | 1.75 ± 0.061 | 22 | 2.27 ± 0.236 | 0.52 |
| 2+ | midlab. | 74 | 0.80 ± 0.043 | 22 | 0.95 ± 0.064 | 0.15 |
| 2+ | mesiolab. | 74 | 1.72 ± 0.059 | 22 | 1.93 ± 0.126 | 0.21 |
| 2+ | mesioling. | 73 | 1.27 ± 0.053 | 22 | 1.86 ± 0.177 | 0.59 ± 0.185 |
| 2+ | midling. | 74 | 1.09 ± 0.052 | 22 | 1.25 ± 0.110 | 0.16 |
| 2+ | distoling. | 74 | 1.37 ± 0.052 | 22 | 2.27 ± 0.202 | 0.90 ± 0.209 |

impossible to decide the cause in any particular case. In this material there were no persons with appreciable swelling of the gingival margin. Whatever the cause of deepened pocket, it is clear that it offers a greater chance of retention than the more shallow sulcus and that it might therefore contribute to the maintainance of the inflammatory condition.

In the younger group comparison has been made of the manner in which the depth of the pocket is related to filled and intact teeth, and, further, to crowding in the upper incisor region and normal spacing. The differences in the two cases were small throughout and both positive and negative in sign.

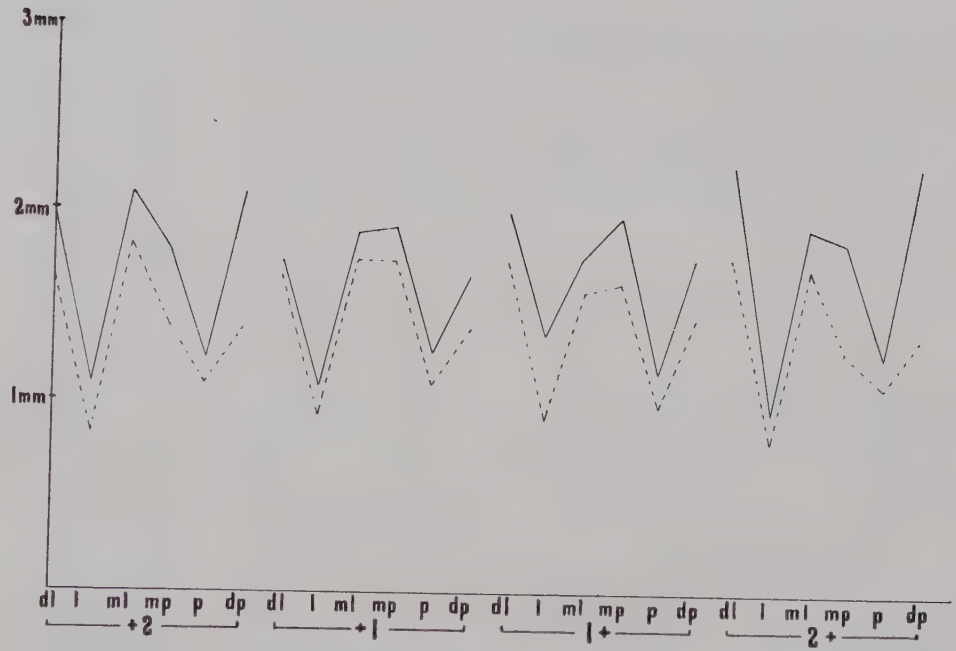


*Fig. 18. The depth of the gingival pocket with no inflamed gingiva. Older group = continuous line; younger group = broken line.*

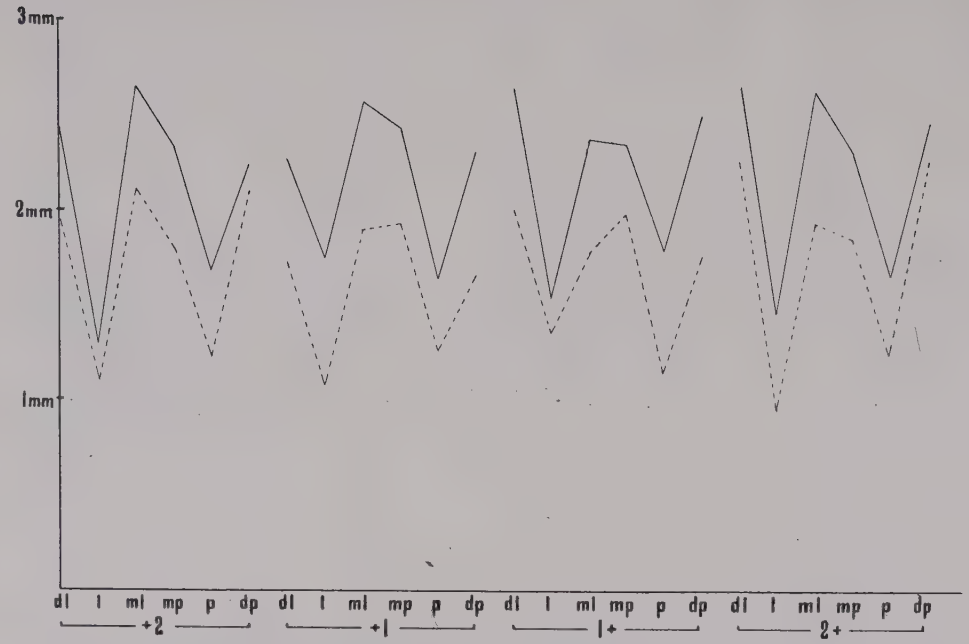


*Fig. 19. The depth of the gingival pocket (older group). For teeth with gingivitis of surrounding tissue = continuous line: for teeth without gingivitis = broken line.*

The younger group was further divided into two roughly equal parts. One had a total of 26 or more occlusion points and the other 25 or less. It proved that the mean values of the pocket depths in the latter group were throughout less than in the former. The differences were practically all small with only 2 probable.

In the older group the depths of the pockets were compared among those who brushed their teeth daily and those who did not or very irregularly. In the great majority of cases the mean values of the depth for daily brushing were less, with 3 significant and 3 probable differences affecting all four teeth.

The material from the two latter examinations was treated by the $\chi^2$ test, showing the same close agreement as in previous cases.

An examination of the older group to see how the pocket depth is influenced by other separate external factors proved unprofitable. The factors display covariation as was pointed out above. The carious defects are further appreciably more common in the older than in the younger group, so that one often finds carious injuries and fillings on the same tooth. The importance of each separate factor is therefore difficult to assess.

If one compares the values of the pocket depths obtained in these investigations with those reported in the chapter on the literature it is found that the mean values for uninflamed gingiva are somewhat greater than those which are for the most part given as normal. The distribution of the pocket depth around the tooth reported by e. g. *Orban & Köhler* (1924), *Blumentritt* (1926) and *Stärke* (1947) with the shallowest pocket on the labial side, then lingual, and the deepest pockets proximally, is in agreement with the result obtained in this investigation. In contradiction to the findings of *Kronfeld* (1933) but in accord with *Blumentritt* (1926) it has appeared in this investigation that the pocket depth in the older group is on the average greater than in the younger also when signs of gingivitis around the tooth are absent.

Provided that the free gingival margin of the older group has not moved in the direction of the incisal edge (see next chapter), the base of the gingival pocket during life has been displaced apically, which serves as proof of the further eruption of the tooth after its first contact with the antagonist.

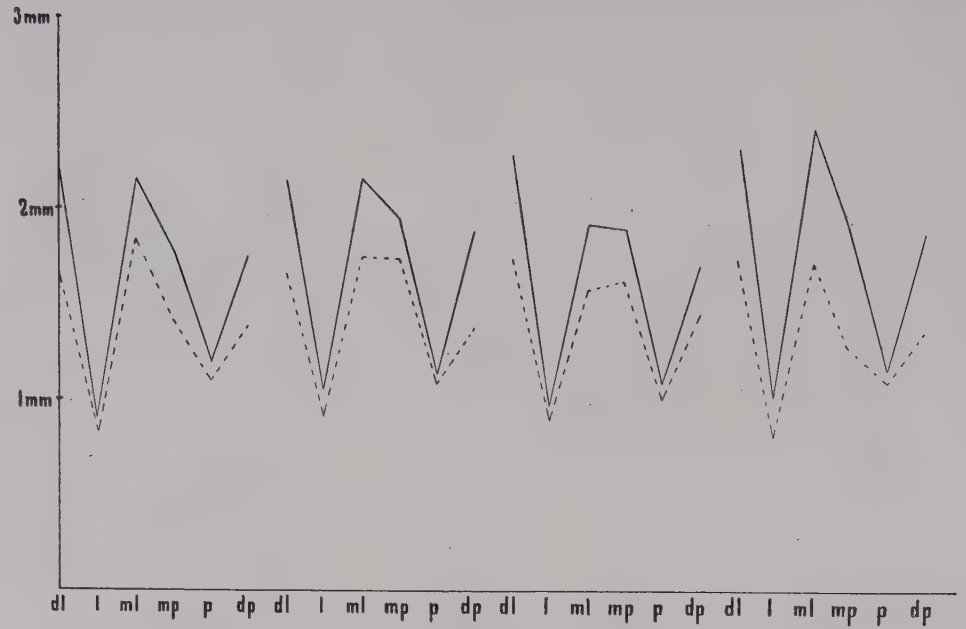


*Fig. 20. The depth of the pocket (younger group) for teeth with gingivitis of surrounding tissue = continuous line: for teeth gingivitis =. broken line.*

The only investigation of a more systematic nature of the depth values with statistically treated material which has been reported in the literature is that of *Castenfelts* (1950). He, however, investigated the depth in the case of ordinary chronic parodontopathies and not under normal conditions. His results are in agreement with the present author's in respect to gingivitis. There is not to be found any investigation of the influence of the other factors on the depth of the pocket.

## CHAPTER VIII

# The visible dental crown

The term "visible dental crown" denotes that part of the tooth which is uncovered by surrounding tissue and therefore visible in the oral cavity. On account of the wave form of the gingival margin the length of the visible crown is greatest labially and lingually and least on the proximal sides. For the reasons stated in Chap. III the estimation of the position of the gingival margin was not performed intra-orally but on a cast. The numerical differences in measurement on the cast and in the mouth are also given in that chapter. In the majority of cases the length of the visible crown has been measured at six places around each tooth, four close to the contact points (two labial — ml, dl — and two palatinal — mp, dp), one mid-labial (l) and one mid-lingual (p).

Sometimes it has not been possible to get the cast of the gingival margin distinct in all places (on account of calculus deposits, etc.). In such places, of course, the measurements have not been made.

It might be thought that the position of the gingival margin vis-à-vis the tooth would be variable, but repeated measurement proved that the position was in fact fairly constant, at least over some months.

In Table 47 the longitudinal measurements of the visible dental crown of the older and younger groups are given. It can be seen that the lengths certainly expose differences between the two groups for each measurement but that the tendency is far from uniform. In places (on +1 and 1+) the length is greater in the younger group, with a statistically significant difference, while in some other places one can find that the values are greater for the older group, likewise with significant differences. A treatment of the material with the $\chi^2$ test in which only one value is used per tooth (the different values of the length around the same tooth are cor-

*Table 47. Length of visible crown (mm) (younger and older groups)*

| | | Older group | | Younger group | | Difference |
|---|---|---|---|---|---|---|
| Tooth | Measured | No. | $M \pm \varepsilon_M$ | No. | $M \pm \varepsilon_M$ | $D \pm \varepsilon_D$ |
| +2 | distolab. | 80 | 6.58 ± 0.26 | 97 | 6.17 ± 0.10 | 0.41 ± 0.28 |
| +2 | midlab. | 80 | 8.43 ± 0.28 | 97 | 8.58 ± 0.10 | —0.15 ± 0.29 |
| +2 | mesiolab. | 79 | 6.08 ± 0.32 | 97 | 5.40 ± 0.10 | 0.68 ± 0.33 |
| +2 | mesioling. | 74 | 6.73 ± 0.29 | 95 | 6.04 ± 0.10 | 0.69 ± 0.30 |
| +2 | midling | 78 | 8.17 ± 0.25 | 96 | 8.22 ± 0.12 | —0.05 ± 0.28 |
| +2 | distoling. | 75 | 6.88 ± 0.25 | 96 | 6.39 ± 0.11 | 0.49 ± 0.27 |
| +1 | distolab. | 94 | 7.10 ± 0.25 | 95 | 7.04 ± 0.11 | 0.06 ± 0.27 |
| +1 | midlab. | 96 | 8.97 ± 0.24 | 96 | 10.15 ± 0.11 | —1.18 ± 0.26 |
| +1 | mesiolab. | 95 | 6.15 ± 0.22 | 96 | 6.36 ± 0.10 | —0.21 ± 0.24 |
| +1 | mesioling. | 94 | 6.23 ± 0.22 | 96 | 6.30 ± 0.10 | —0.07 ± 0.24 |
| +1 | midling. | 96 | 8.87 ± 0.22 | 96 | 9.20 ± 0.12 | —0.33 ± 0.25 |
| +1 | distoling. | 90 | 7.74 ± 0.23 | 95 | 7.22 ± 0.11 | 0.52 ± 0.26 |
| 1+ | distolab. | 94 | 7.36 ± 0.22 | 99 | 6.99 ± 0.10 | 0.37 ± 0.24 |
| 1+ | midlab. | 94 | 9.23 ± 0.25 | 99 | 10.06 ± 0.11 | —0.83 ± 0.27 |
| 1+ | mesiolab. | 94 | 6.29 ± 0.21 | 99 | 6.35 ± 0.09 | —0.06 ± 0.23 |
| 1+ | mesioling. | 93 | 6.37 ± 0.19 | 99 | 6.16 ± 0.10 | 0.21 ± 0.21 |
| 1+ | midling. | 94 | 9.07 ± 0.20 | 99 | 9.16 ± 0.11 | —0.09 ± 0.23 |
| 1+ | distoling. | 91 | 7.73 ± 0.22 | 99 | 7.23 ± 0.10 | 0.50 ± 0.24 |
| 2+ | distolab. | 82 | 6.83 ± 0.26 | 97 | 6.09 ± 0.09 | 0.74 ± 0.27 |
| 2+ | midlab. | 83 | 8.56 ± 0.27 | 97 | 8.24 ± 0.10 | 0.32 ± 0.29 |
| 2+ | mesiolab. | 83 | 6.47 ± 0.31 | 97 | 5.25 ± 0.13 | 1.22 ± 0.34 |
| 2+ | mesioling. | 79 | 7.38 ± 0.21 | 96 | 5.74 ± 0.11 | 1.64 ± 0.24 |
| 2+ | midling. | 80 | 8.66 ± 0.22 | 96 | 8.03 ± 0.13 | 0.63 ± 0.26 |
| 2+ | distoling. | 80 | 7.11 ± 0.23 | 96 | 6.35 ± 0.08 | 0.76 ± 0.25 |

related) shows that there is very close agreement between the two groups in respect of measurements of the four teeth. The probability of obtaining o chance less satisfactory agreement is consistently greater than 0.8.

The values obtained show on the whole that the visible dental crown is longer in the case of older persons. If one takes attrition into consideration it is clear that recession of the gingiva occurs during the years. Whether that is a result of the active or the passive eruption of the tooth, or a combination of both, it is not possible to decide from such an examination. The results of this investigation thus agree in this respect with the whole of this group of authors who adhere to the theory of continuous eruption.

*Table 48. Mean values of angles between the two mesial and between the two distal proximal measuring points on the gingival margin (younger and older groups)*

| Tooth | Measured | Older group No. | Older group $M \pm \varepsilon_M(°)$ | Younger group No. | Younger group $M \pm \varepsilon_M(°)$ | Difference $D \pm \varepsilon_D(°)$ |
|---|---|---|---|---|---|---|
| +1 | Mesially | 94 | $36.2 \pm 2.1$ | 96 | $38.7 \pm 1.5$ | $-2.5 \pm 2.6$ |
| | Distally | 90 | $41.7 \pm 2.9$ | 94 | $43.2 \pm 1.3$ | $-1.5 \pm 3.2$ |
| $\bar{1}+$ | Mesially | 93 | $36.4 \pm 2.1$ | 99 | $38.8 \pm 1.5$ | $-2.4 \pm 2.6$ |
| | Distally | 91 | $42.5 \pm 2.3$ | 99 | $41.6 \pm 1.4$ | $0.9 \pm 2.7$ |
| +2 | Mesially | 74 | $51.6 \pm 3.3$ | 95 | $53.1 \pm 1.3$ | $-1.5 \pm 3.5$ |
| | Distally | 75 | $58.7 \pm 3.1$ | 95 | $56.3 \pm 1.8$ | $2.4 \pm 3.6$ |
| 2+ | Mesially | 79 | $58.0 \pm 2.9$ | 96 | $52.1 \pm 1.7$ | $5.9 \pm 3.4$ |
| | Distally | 79 | $58.6 \pm 2.7$ | 96 | $55.6 \pm 1.7$ | $3.0 \pm 3.2$ |

In the investigation it appeared (as the figures would seem to suggest) that the recession of the gingiva in the older group is generally most rapid proximally, so that the gingival margin of this group is not so pronouncedly fluted as in the case of the younger people. Sometimes one papilla is found unaltered among all the other receded papillas of the anterior region. This occurs most frequently between the medial incisors (see Table 47). This is perhaps explained by the strengthening of this papilla by connective tissue from the frenulum labii which insert in close proximity, or it may be due to the more resistant bone beneath the papilla. In order to be able to make a safe comparison between the mesurements of younger and older people, it is necessary that the measuring points on the gingival margin should lie symmetrically in both groups. On account of the fluted form of the gingiva one can obtain quite diverging values at different points around the same tooth. In the older group the number of cases of diastema was greater and the number of crowding less that in the younger group. It might be concluded from this that the proximal measuring points for the older people lie farther in between the teeth and that there is consequently a proportionally lower value for the length of the visible crown. By means of a determination of the mid-point angle between the two proximal measuring points, mesially and distally (Chap. III), it could be proved that this was not the case (Table 48). The explanation is probably that the wider spacing of the teeth in other

cases is compensated by the occurence of larger contact surfaces through interdental wear. This led to a drawing apart of the measuring points.

Another source of error in measurement of the visible dental crown is that one tooth can, on loss of its antagonist, erupt into the oral cavity with a speed in excess of the normal. For this reason it may be possible to find abnormally long visible crowns among older people. Such cases have however not been observed in this research material.

It is noteworthy that, in the younger group, values for the visible crown are almost invariably greater for the left than the right side of the mouth, while the contrary is the case in respect of the older people. It seems hardly likely that it should depend on systematic error, for in such a case the differences would agree for both groups. It might be that the difference appears by chance. Application of the $\chi^2$ test shows however the same close agreement as in the previous groups.

It appears desirable to describe the manner in which gingival inflammation can affect the visible crown length. Such an examination was performed with the young group. Swelling was insignificant throughout practically the whole of the material judging from the mean, which however does not prevent its having contributed in some odd cases to the pocket depth apparent in gingivitis.

Further, the influence on the gingival margin of dental care was tested. It proved that in practically all places the gingiva was somewhat recessive on teeth with fillings (Fig. 21). Three of the differences were significant and one probable. In the determination of the angles, performed to establish the relative position of the proximal measuring points, it was found that during measuring one could not approach so near the contact point in cases with a large number of fillings as when there were fewer fillings (Table 49). It is probable that this was due to the fillings being built out more than would be the case with the natural rounded form of the tooth. The difference in the angle value is however insignificant and could hardly affect the results of the measurements.

A comparison of the position of the gingival margin in crowding of the teeth and diastema is impossible to perform, since in these cases with the method used one cannot get symmetrically placed proximal measuring points. On the labial side, moreover, the gingival margin often follows an abnormal course in the case of crowding.

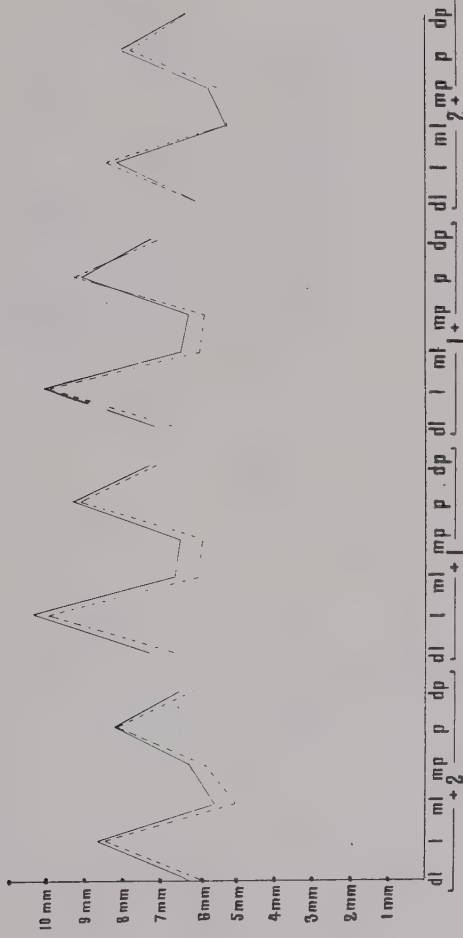


*Fig. 21. The length of the visible crown (younger group). Teeth with fillings = continuous line: intact teeth = broken line.*

*Table 49. Mean values of angles between the two mesial and between the two distal proximal measuring points on the gingival margin (upper incisor region) for different numbers of filling points (younger group)*

| | | 5 and above filled surfaces | | 4 and less filled surfaces | | Difference |
|---|---|---|---|---|---|---|
| Tooth | Measured | No. | $M \pm \varepsilon_M(°)$ | No. | $M \pm \varepsilon_M(°)$ | $D \pm \varepsilon_D(°)$ |
| +1 | Mesially | 50 | $42.4 \pm 2.1$ | 46 | $34.6 \pm 2.0$ | $7.8 \pm 2.9$ |
| | Distally | 50 | $45.5 \pm 1.8$ | 44 | $40.5 \pm 1.8$ | $5.0 \pm 2.5$ |
| 1+ | Mesially | 52 | $41.6 \pm 2.0$ | 47 | $35.6 \pm 2.1$ | $6.0 \pm 2.9$ |
| | Distally | 52 | $43.5 \pm 1.9$ | 47 | $39.4 \pm 1.9$ | $4.1 \pm 2.7$ |
| +2 | Mesially | 51 | $54.6 \pm 1.6$ | 44 | $51.4 \pm 2.0$ | $3.2 \pm 2.6$ |
| | Distally | 50 | $58.4 \pm 2.3$ | 45 | $54.0 \pm 2.8$ | $4.4 \pm 3.6$ |
| 2+ | Mesially | 51 | $53.6 \pm 2.4$ | 45 | $50.5 \pm 2.3$ | $3.1 \pm 3.3$ |
| | Distally | 51 | $58.1 \pm 2.2$ | 45 | $52.7 \pm 2.6$ | $5.4 \pm 3.4$ |

## CHAPTER IX

# The x-ray investigation

The distance from the alveolar margin and the enamel margin to the centre of the incisal edge was measured on x-ray film by means of the technique described in Chap. III. All distances were, where possible, measured both distally and mesially. Unfortunately it occurred in a comparatively large number of cases that the position of the enamel margin for various reasons could not be established. From these measurements information was obtained on the length of the physiologic crown (that part of the crown which does not lie imbedded in the alveolar bone) and the anatomic crown (that part of the tooth which is normally covered with enamel). By subtracting the latter value from the former the distance between the enamel and alveolar margins was obtained. The measurements given in this chapter are directly measured on the x-ray film and no correction for enlargement has in general been made. It is however an operation easy to perform. Since the enlargement is proportional to the distance, one needs only divide the values by the linear enlargement factor, 30.5 / 28.5 = 1.070 / 30.5 cm = the distance between focus and film plane; 28.5 cm = distance between focus and bisecting plane of the tooth/.

Those sources of error inherent in the various forms of x-ray projection have been enumerated by *Herulf* (1940 and 1950). Below, however, the practical consequences of some of the errors which might occur in this investigation will be touched upon. In order that the enlargement factor shall be calculable in the simple way mentioned above it is necessary that the proximal-incisal enamel margins, the incisal edges and the lowest alveolar margin should lie in the same plane, the bisecting plane of the dental crown. Small deviations from this position are however to be expected in particular cases. In the case of the position of the enamel margin, the displacements in the

horizontal plane are extremely small, a fact borne out by any examination of extractions. Further these would probably be found to about the same extent in both the groups since they are independent of age. The extreme incisal part of the bone margin might on the other hand be thought, especially in the older group, to lie relatively far labially or lingually in relation to the dental crown's bisecting plane. The distance required to be measured is not the direct distance between the bone margin and the incisal edge but the distance between the projection of these two points on the standard axis. If the bone margin lies labially in relation to the bisecting plane of the dental crown, the distance projected on the x-ray film will usually be too great (if the central ray intersects the bisecting plane between the incisal edge and the bone margin projected to the standard axis), and too small if it lies lingually. If one assumes the condition that the bone margin should be a maximum of 5 mm in front of the bisecting plane of the dental crown, the linear enlargement factor would be maximum $\frac{30.5}{28} = 1.089$. If the point should lie in the bisecting plane the linear enlargement factor would, according to the above, be 1.070. In an actual measurement of the distance of 10 mm the measurement on the x-ray film is 10.70 and 10.89 mm with the relatively insignificant difference of 0.19 mm. By the same principle the measurement is reckoned as a minimum of 10.52 mm if the alveolar bone lies 5 mm orally of the bisecting plane of the dental crown. In the same way the most incisally situated part of the crown in the older group will sometimes, through the effect of wear, lie labially of the bisecting plane. The error is calculated in the same way as above and has a lower maximum magnitude since the sagittal section of the dental crown can hardly be considered to be as large as 1 cm.

To give a measurement of the degree of attrition, Table 50 has been composed to show the anatomic crown's length in the older group subtracted from the corresponding measurement in the younger. This procedure is conditional on the fact that originally the anatomic crown is on the average equally high for younger and older persons. At all measuring points the difference between the two groups with respect to the anatomic crown length is statistically significant. The comparatively high value of sigma in the older group is an expression, for one thing, of the widely varying values of the separate crown

*Table 50. Length of the anatomic crown, measured mesially and distally (younger and older groups)*

| | | Younger group | | | Older group | | | Difference |
|---|---|---|---|---|---|---|---|---|
| Measured | Tooth | No. | $M \pm \varepsilon_M$ mm | σ | No. | $M \pm \varepsilon_M$ mm | σ | $D \pm \varepsilon_D$ |
| Mesially | + 2 | 70 | 7.89 ± 0.10 | 0.85 | 61 | 5.85 ± 0.33 | 2.55 | 2.04 ± 0.34 |
| Mesially | + 1 | 85 | 8.83 ± 0.09 | 0.85 | 84 | 5.93 ± 0.28 | 2.58 | 2.90 ± 0.29 |
| Mesially | 1 + | 83 | 8.78 ± 0.10 | 0.90 | 79 | 6.24 ± 0.27 | 2.44 | 2.54 ± 0.29 |
| Mesially | 2 + | 74 | 7.83 ± 0.10 | 0.83 | 53 | 6.32 ± 0.32 | 2.30 | 1.51 ± 0.34 |
| Distally | + 2 | 66 | 8.09 ± 0.08 | 0.64 | 42 | 5.73 ± 0.41 | 2.67 | 2.36 ± 0.42 |
| Distally | + 1 | 87 | 9.14 ± 0.09 | 0.80 | 75 | 6.14 ± 0.30 | 2.59 | 3.00 ± 0.31 |
| Distally | 1 + | 89 | 9.17 ± 0.09 | 0.84 | 75 | 6.76 ± 0.26 | 2.28 | 2.41 ± 0.28 |
| Distally | 2 + | 74 | 8.18 ± 0.08 | 0.64 | 47 | 6.47 ± 0.35 | 2.40 | 1.71 ± 0.36 |

*Table 51. Enamel margin—alveolar margin distance measured mesially and distally (younger and older groups)*

| | | Younger group | | Older group | | Difference |
|---|---|---|---|---|---|---|
| Measured | Tooth | No. | $M \pm \varepsilon_M$ mm | No. | $M \pm \varepsilon_M$ mm | $D \pm \varepsilon_D$ |
| Mesially | +2 | 68 | 1.56 ± 0.09 | 59 | 4.55 ± 0.23 | −2.99 ± 0.25 |
| Mesially | +1 | 85 | 1.48 ± 0.08 | 84 | 4.25 ± 0.19 | −2.77 ± 0.21 |
| Mesially | 1+ | 83 | 1.56 ± 0.07 | 79 | 4.12 ± 0.17 | −2.56 ± 0.18 |
| Mesially | 2+ | 71 | 1.77 ± 0.11 | 53 | 4.52 ± 0.30 | −2.75 ± 0.32 |
| Distally | +2 | 66 | 2.10 ± 0.09 | 42 | 4.58 ± 0.26 | −2.48 ± 0.28 |
| Distally | +1 | 81 | 1.81 ± 0.08 | 72 | 4.65 ± 0.21 | −2.84 ± 0.22 |
| Distally | 1+ | 83 | 1.65 ± 0.07 | 71 | 4.72 ± 0.22 | −3.07 ± 0.23 |
| Distally | 2+ | 73 | 1.96 ± 0.10 | 45 | 4.96 ± 0.32 | −3.00 ± 0.34 |

lengths. In reality, all degrees of attrition occur in the older material, from practically none at all to right down to the root. In some cases where the tooth is worn below the enamel margin, the length of the anatomic crown should be reckoned as a negative value. In the calculations these values have been taken up to 0 mm since the magnitude of the negative values was impossible to measure. The mean values of the attrition should therefore probably be some small fraction larger that those in the table. They are in any case relatively small if they are compared with *Nicholl*'s information (Chap. III) on the race of primitive people. In his material there was a wear of 1 mm for every five or six years. The difference should of course depend to a great extent on different diets.

In the present author's material attrition is most pronounced in the left part of the mouth, Table 50. This is possibly connected with the individual chewing habits.

The mean values of attrition are between 1.4 and 2.8 mm, enlargment taken into consideration.

The distance from the alveolar bone margin to the enamel margin (Table 51) is also greatest in the older group — with a statistically significant difference compared with the younger group — pointing to continuous eruption. Attrition does not, however, keep pace with "breaking down of the bone" but the physiologic crown displays at nearly all measuring points a greater length in the older group, with a difference in relation to the younger significant for two teeth and probable for the third (Table 52). Lengthening of the physiologic

*Table 52. Length of physiologic crown, measured mesially and distally (younger and older groups)*

| | | Younger group | | | Older group | | | Difference mm |
|---|---|---|---|---|---|---|---|---|
| Measured | Tooth | No. | $M \pm \varepsilon_M$ mm | $\sigma$ | No. | $M \pm \varepsilon_M$ mm | $\sigma$ | $D \pm \varepsilon_D$ |
| Mesially | + 2 | 81 | 9.53 ± 0.11 | 0.95 | 78 | 10.73 ± 0.32 | 2.81 | —1.20 ± 0.34 |
| Mesially | + 1 | 92 | 10.33 ± 0.08 | 0.78 | 93 | 10.24 ± 0.24 | 2.27 | 0.09 ± 0.25 |
| Mesially | 1 + | 95 | 10.38 ± 0.09 | 0.89 | 93 | 10.39 ± 0.21 | 2.05 | —0.01 ± 0.23 |
| Mesially | 2 + | 83 | 9.60 ± 0.10 | 0.88 | 80 | 11.18 ± 0.30 | 2.64 | —1.58 ± 0.32 |
| Distally | + 2 | 80 | 10.24 ± 0.11 | 0.99 | 78 | 10.73 ± 0.29 | 2.60 | —0.49 ± 0.31 |
| Distally | + 1 | 85 | 10.94 ± 0.10 | 0.94 | 88 | 11.13 ± 0.27 | 2.51 | —0.19 ± 0.29 |
| Distally | 1 + | 86 | 10.89 ± 0.09 | 0.87 | 85 | 11.66 ± 0.24 | 2.21 | —0.77 ± 0.26 |
| Distally | 2 + | 79 | 10.22 ± 0.10 | 0.93 | 79 | 11.18 ± 0.28 | 2.48 | —0.96 ± 0.30 |

*Table 53. Enamel margin—alveolar margin distance for different length of anatomic crown (older group)*

| Tooth | Measured | Length of anatomic crown | Enamel margin-bone margin distance No. | Enamel margin-bone margin distance $M \pm \varepsilon_M$ mm | Difference $D \pm \varepsilon_D$ |
|---|---|---|---|---|---|
| +2 | Mesially | 6.5 mm and above | 28 | 4.36 ± 0.24 | 0.35 ± 0.46 |
| | | less than 6.5 mm | 31 | 4.71 ± 0.39 | |
| +2 | Distally | 6.5 mm and above | 17 | 4.02 ± 0.20 | 0.96 ± 0.46 |
| | | less than 6.5 mm | 18 | 4.98 ± 0.41 | |
| +1 | Mesially | 6.8 mm and above | 42 | 3.53 ± 0.16 | 1.45 ± 0.34 |
| | | less than 6.8 mm | 42 | 4.98 ± 0.30 | |
| +1 | Distally | 6.8 mm and above | 31 | 3.91 ± 0.24 | 1.33 ± 0.41 |
| | | less than 6.8 mm | 36 | 5.24 ± 0.33 | |
| 1+ | Mesially | 6.8 mm and above | 39 | 3.56 ± 0.19 | 1.11 ± 0.32 |
| | | less than 6.8 mm | 40 | 4.67 ± 0.26 | |
| 1+ | Distally | 6.8 mm and above | 31 | 4.25 ± 0.25 | 0.95 ± 0.44 |
| | | less than 6.8 mm | 32 | 5.20 ± 0.36 | |
| 2+ | Mesially | 7.2 mm and above | 26 | 4.16 ± 0.30 | 0.71 ± 0.59 |
| | | less than 7.2 mm | 27 | 4.87 ± 0.51 | |
| 2+ | Distally | 7.2 mm and above | 17 | 4.09 ± 0.33 | 1.65 ± 0.65 |
| | | less than 7.2 mm | 19 | 5.74 ± 0.61 | |

crown is then relatively unimportant between about —0.1 and 1.5 mm (enlargement taken into consideration). It should however be borne in mind that it is the mean value which is concerned and that in any particular case it may show an appreciably larger value.

It was not possible to find support for the observation of *Bohrer* (1932) in general concerning mesial resorption of the bone and building up distally in connection with the function of the tooth. It would, had such been the case, have been evident from the figures in Table 51.

Of particular interest is the examination of how the bone septa (enamel margin — alveolar margin distance) behave under different degrees of attrition. In this investigation the present author proceded by dividing each dental group of older people into two roughly equal parts, one with the length of crown under a given value and the other above, Table 53. It appeared surprisingly enough that all differences between the two sub-groups gave greater values for the distance

between enamel and alveolar margins in the group with the shorter anatomic crown. For two teeth (1 + and + 1) there were statistically significant differences. It would thus seem hardly likely that the view of *Gottlieb* and others who hold that the wearing of the crown should be to the advantage of the periodontium, should be correct. Instead *Adloff*'s opinion would seem to be nearer the truth.

The conclusions drawn from the mensuration results in the older group are however somewhat uncertain, because of the co-variation between different factors mentioned in Chap. VI (see below also).

It is probable that both attrition and the increased enamel margin — alveolar margin distance are dependent on another factor, namely the occlusion. This changes over the years so that what is normal in younger people cannot be considered so among older folk (*Moses*, 1946). In general there is, in connection with wear of the teeth, a displacement of the lower jaw so that subjects gradually develop edge to edge bite instead of overbite as in younger years. This has been pointed out in connection with primitive people of to-day (*Campbell*, 1925, and *Hilming* and *Pedersen*, 1940). From *Hilming* and *Pedersen*'s published work one can calculate that among eskimos there is a lower percentage of straight bites before 20 years of age than after and the difference is significant. It might however be observed that these results obtained with primitive people are perhaps not valid for other material. However, it is a general impression that the edge-to-edge bite is more common among older people but no precise investigations of the problem seem to exist. A theoretical account by *Lundström* (1946) supports this assumption. In certain cases where overbite still exists in the rest position, the lower jaw often moves forward during chewing when lateral teeth are missing, so that the bite is perhaps in effect an edge-to-edge bite, *Dalmore* (1896) has written on this point.

In the older material of the present author there were several cases of edge-to-edge bite. No record of the number could be made, however, because there was every type of transition stage between overbite and edge-to-edge which were difficult to classify.

When treating the material some connection between the degree of attrition and the total number of occlusion points was sought (Table 54). It appeared that the sub-group of older people, who had a lower number of occlusion points, displayed shorter anatomic crowns at all

*Table 54. Length of anatomic crown (in mm) for different numbers of occlusion points (older group)*

| | | Occlusion points 12 and less | | Occlusion points 13 and above | | Difference |
|---|---|---|---|---|---|---|
| Measured | Tooth | No. | $M \pm \varepsilon_M$ | No. | $M \pm \varepsilon_M$ | $D \pm \varepsilon_D$ |
| Mesially | + 2 | 30 | 5.05 ± 0.49 | 31 | 6.62 ± 0.40 | 1.57 ± 0.63 |
| Mesially | + 1 | 38 | 5.08 ± 0.46 | 46 | 6.63 ± 0.32 | 1.55 ± 0.56 |
| Mesially | 1 + | 34 | 5.26 ± 0.44 | 45 | 6.98 ± 0.31 | 1.72 ± 0.54 |
| Mesially | 2 + | 19 | 5.33 ± 0.75 | 34 | 6.88 ± 0.23 | 1.55 ± 0.78 |
| Distally | + 2 | 22 | 5.10 ± 0.58 | 20 | 6.42 ± 0.56 | 1.32 ± 0.81 |
| Distally | + 1 | 33 | 5.19 ± 0.47 | 42 | 6.89 ± 0.36 | 1.70 ± 0.59 |
| Distally | 1 + | 30 | 5.94 ± 0.45 | 45 | 7.30 ± 0.31 | 1.36 ± 0.55 |
| Distally | 2 + | 17 | 5.44 ± 0.84 | 30 | 7.05 ± 0.23 | 1.61 ± 0.87 |

*Table 55. Enamel margin—alveolar margin distance (in mm) for different numbers of occlusion points (older group)*

| | | Occlusion points 12 and less | | Occlusion points 13 and above | | Difference |
|---|---|---|---|---|---|---|
| Measured | Tooth | No. | $M \pm \varepsilon_M$ | No. | $M \pm \varepsilon_M$ | $D \pm \varepsilon_D$ |
| Mesially | + 2 | 28 | 5.06 ± 0.41 | 31 | 4.08 ± 0.22 | 0.98 ± 0.47 |
| Mesially | + 1 | 38 | 4.60 ± 0.32 | 46 | 3.97 ± 0.21 | 0.63 ± 0.38 |
| Mesially | 1 + | 34 | 4.77 ± 0.32 | 45 | 3.64 ± 0.14 | 1.13 ± 0.35 |
| Mesially | 2 + | 19 | 5.12 ± 0.66 | 34 | 4.19 ± 0.28 | 0.93 ± 0.72 |
| Distally | + 2 | 22 | 5.10 ± 0.42 | 20 | 4.00 ± 0.26 | 1.10 ± 0.49 |
| Distally | + 1 | 32 | 5.16 ± 0.36 | 40 | 4.25 ± 0.23 | 0.91 ± 0.43 |
| Distally | 1 + | 28 | 5.25 ± 0.40 | 43 | 4.38 ± 0.24 | 0.87 ± 0.47 |
| Distally | 2 + | 16 | 5.88 ± 0.66 | 29 | 4.46 ± 0.30 | 1.42 ± 0.72 |

points of measurements, a result which seems quite natural. The differences were significant for the 1 + mesially and probable for the + 1 at both measuring points.

The application of the $\chi^2$ test to the material — only one value being used for each tooth, namely the mid-labial — showed that close agreement prevailed between the two compared groups with respect to the relative variation of the 4 teeth in the different measurements. The probability is consistently greater than 0.8 that a less satisfactory agreement can be obtained by chance.

Further, it seems conceivable that with poorer occlusion without greater wear of the teeth even greater strain of the periodontium would

occur. This in its turn would perhaps bring about an increase of the distance between alveolar and enamel margins. This did in fact appear to be the case (Table 55). Just what this last argument signifies should be considered carefully, for a connection between the different factors has been pointed out earlier in the older group (Chap. VI), so that the results may also have been influenced by other circumstances, such as poor oral hygiene.

Of the other factors which possibly influence the distance from alveolar to the enamel margins, inflammation of the gingiva is one. In both groups of material, examination was made as to whether there was any difference between those with gingivitis and the normal ones (Tables 56 and 57). It appeared that in both older and younger groups the distance was greater in clinically obvious inflammation than in clinically healthy gingiva. This was true for the greater number of measuring points. In the older group the difference for the mesial measuring point of the +2 and the distal of the 1+ was significant and for the mesial point of the 2+ and the distal of the +2 it was probable.

A study was made of how the enamel alveolar distance varied in the younger group on teeth with fillings and on teeth without. The differences showed that the mean values of the distances were greater for all points on filled teeth. The differences were, however, small throughout and neither significant not probable. Applications of the $\chi^2$ test to the result, in accordance with the principle followed previously, shows an agreement between the groups as close as in the other examinations.

The younger group has also been divided into two with respect to the total number of occlusion points. One of the groups had 25 and less points, and the other over 25. The variation of the distance between alveolar and enamel margins was examined in each case but no displacement found.

It would have been interesting to observe how the state of the bone septa varied with the presence and absence of calculus in the older group. However, the number of cases without calculus where the distance could be measured on x-ray film was too small to permit such an investigation.

For the sake of completeness a comparision was made between the alveolar margin—enamel margin distances for the older people in the

*Table 56. Enamel margin—alveolar margin distance (in mm) for subjects with (a) gingivitis in the upper incisor region (b) clinically normal gingiva (younger group)*

| | | Gingivitis | | No gingivitis | | Difference |
|---|---|---|---|---|---|---|
| Measured | Tooth | No. | $M \pm \varepsilon_M$ | No. | $M \pm \varepsilon_M$ | $D \pm \varepsilon_D$ |
| Mesially | +2 | 19 | 1.50 ± 0.18 | 49 | 1.58 ± 0.11 | −0.08 ± 0.21 |
| Mesially | +1 | 26 | 1.69 ± 0.16 | 59 | 1.39 ± 0.09 | 0.30 ± 0.18 |
| Mesially | 1+ | 22 | 1.66 ± 0.11 | 61 | 1.52 ± 0.09 | 0.14 ± 0.14 |
| Mesially | 2+ | 23 | 1.77 ± 0.22 | 48 | 1.78 ± 0.12 | −0.01 ± 0.25 |
| Distally | +2 | 21 | 2.31 ± 0.14 | 45 | 2.00 ± 0.12 | 0.31 ± 0.18 |
| Distally | +1 | 24 | 2.05 ± 0.14 | 57 | 1.71 ± 0.09 | 0.34 ± 0.17 |
| Distally | 1+ | 24 | 1.93 ± 0.16 | 59 | 1.54 ± 0.07 | 0.39 ± 0.17 |
| Distally | 2+ | 26 | 2.03 ± 0.18 | 47 | 1.93 ± 0.12 | 0.10 ± 0.22 |

*Table 57. Enamel margin—alveolar margin distance (in mm) for subjects with (a) gingivitis in the upper incisor region (b) clinically normal gingiva (older group)*

| | | Gingivitis | | No gingivitis | | Difference |
|---|---|---|---|---|---|---|
| Measured | Tooth | No. | $M \pm \varepsilon_M$ | No. | $M \pm \varepsilon_M$ | $D \pm \varepsilon_D$ |
| Mesially | +2 | 44 | 4.94 ± 0.28 | 15 | 3.40 ± 0.22 | 1.54 ± 0.36 |
| Mesially | +1 | 60 | 4.38 ± 0.22 | 24 | 3.94 ± 0.33 | 0.44 ± 0.40 |
| Mesially | 1+ | 60 | 4.30 ± 0.20 | 19 | 3.56 ± 0.32 | 0.74 ± 0.38 |
| Mesially | 2+ | 37 | 4.94 ± 0.38 | 16 | 3.57 ± 0.38 | 1.37 ± 0.54 |
| Distally | +2 | 28 | 4.98 ± 0.35 | 14 | 3.78 ± 0.30 | 1.20 ± 0.46 |
| Distally | +1 | 53 | 4.85 ± 0.25 | 19 | 4.09 ± 0.36 | 0.76 ± 0.44 |
| Distally | 1+ | 54 | 5.11 ± 0.25 | 17 | 3.50 ± 0.28 | 1.61 ± 0.38 |
| Distally | 2+ | 33 | 5.15 ± 0.40 | 12 | 4.45 ± 0.46 | 0.70 ± 0.61 |

case of daily brushing and where daily brushing was not practised. The results are collected in Table 58. The distance was generally less in the case of daily brushing, with a significant difference between the groups mesially on 1+ and a probable difference mesially on +1. Analysis with the $\chi^2$ test supported this result.

No attempt to establish a co-variation between crowding of the teeth and the distance between alveolar and enamel margins could be ascertained, for in too few cases could the edge of the bone septum be projected free from the adjacent teeth.

*Table 58. Enamel margin—alveolar margin distance (in mm) with and without daily brushing (older group)*

| | | No daily brushing | | Daily brushing | | Difference |
|---|---|---|---|---|---|---|
| Measured | Tooth | No. | $M \pm \varepsilon_M$ | No. | $M \pm \varepsilon_M$ | $D \pm \varepsilon_D$ |
| Mesially | +2 | 27 | $4.71 \pm 0.45$ | 32 | $4.41 \pm 0.21$ | $0.30 \pm 0.50$ |
| Mesially | +1 | 40 | $4.78 \pm 0.31$ | 44 | $3.78 \pm 0.19$ | $1.00 \pm 0.36$ |
| Mesially | 1+ | 37 | $4.69 \pm 0.25$ | 42 | $3.62 \pm 0.21$ | $1.07 \pm 0.33$ |
| Mesially | 2+ | 20 | $4.56 \pm 0.65$ | 33 | $4.50 \pm 0.28$ | $0.06 \pm 0.71$ |
| Distally | +2 | 20 | $4.57 \pm 0.40$ | 22 | $4.59 \pm 0.35$ | $-0.02 \pm 0.53$ |
| Distally | +1 | 37 | $5.07 \pm 0.34$ | 35 | $4.21 \pm 0.22$ | $0.86 \pm 0.40$ |
| Distally | 1+ | 31 | $5.21 \pm 0.33$ | 40 | $4.35 \pm 0.29$ | $0.86 \pm 0.44$ |
| Distally | 2+ | 18 | $5.13 \pm 0.63$ | 27 | $4.86 \pm 0.33$ | $0.27 \pm 0.71$ |

With the exception of *Herulf*'s (1950) work, there is no account of x-ray investigations of the type described above to be found in the literature. *Herulf*'s examination was restricted to the lower anterior region, and the problems dealt with were for the most part quite different from those discussed in this paper so that no comparison can be made in any but perhaps two respects. The first concerns the enamel margin — alveolar bone distance in the case of pathologically altered gingiva, *Herulf* too finding that the distance is greater in this than in the normal state. Again, it appeared from *Herulf*'s investigation that the distances between alveolar and enamel margins were, on the average greater between the medials than between medials and laterals. In the upper jaw the present investigation points to the contrary. This fact has a probable connection with anatomic conditions, for example, in the strengthening of the bone which occurs through the sagitally placed cortical plates of the sutura palatina mediana.

## Summary

It is necessary to recognise the state of the periodontal tissue for different ages in order to have a starting point for the estimation of pathological processes. As will be seen from the survey of the literature on the subject, the previous investigational work does not supply sufficient information. For this reason information has been collected from material consisting of 101 subjects with an age median of 24.3 years and 102 subjects with a median age of 72.0 years. The part of the mouth examined was the maxillary incisor region. The investigation yielded the following results.

1. The percentage of subjects with gingivitis — reddening of the gingiva, possibly combined with tendencies towards haemorrhage — was 32.7 % in the younger group and 74.5 % in the older. The difference was statistically significant. In cases of gingivitis the marginal extent of the erythema (the number of gingivitis points according to the method of calculation used) was greater in the older than in the younger group.

2. The mean values of the depth of the gingival pockets at various measuring points around the teeth were greater for the older group. The mean values varied in the younger group between 0.84 and 1.90 mm, and in the older group between 1.23 and 2.57 mm.

3. The mean values of the depth of the gingival pockets around teeth with gingivitis-free surrounding tissue were consistently greater in the older group. The values varied in the younger group between 0.80 and 1.83 mm and in the older between 0.95 and 2.27 mm.

4. The length of the visible crown showed a tendency towards higher values in the older group in spite of attrition. Retraction of the gingiva through age, which generally proceeds most rapidly interdentally, sometimes did not affect one or two papillas, leaving them unchanged; this was most often the case with the upper medials.

5. Attrition — expressed as a reduction in the length of the crown — during those years distinguishing the younger from the older group, varied between 1.4 and 2.8 mm on the average.

6. The distance between the alveolar bone margin and the enamel margin for different teeth was greatest for the older group. The reduction through attrition of the anatomic crown length did not however keep pace with the "resorption" of the bone, so that portion of the tooth not imbedded in the jaw was longer in the older group. The difference proved however to be relatively insignificant, between —0.1 and 1.5 mm.

7. The distance from the enamel margin to the alveolar bone margin was, surprisingly enough, longer for teeth with shorter anatomic crowns (greater attrition) in the older group.

8. A side result from the treatment of the information on the condition of the teeth was the discovery in the older and more caries-resistant group that the number of caries attacks on the upper laterals, which, in the younger group was of about the same order as the number of the medials, was considerably greater than the number of attacks on the medials.

9. In the older group a covariation appears between the frequency of brushing and the number of filled surfaces, the number of untreated carious defects, the number of total occlusion points, diastemas and crowding. This means that any estimation of the influence of any one factor on the periodontium must be made with care.

Calculus and materia alba were more common in the older group where there were also a number of teeth with an abnormal degree of mobility.

10. In gingivitis there appeared a consistently greater depth of pocket and distance between alveolar bone margin and enamel margin than in the case of non-inflamed gingiva.

11. With a greater number of occlusion points it was found that there was a tendency towards greater depth of pocket, but there was no appreciable change in the number of gingivitis points or in the distance between enamel and alveolar margins (younger group). In the older group there was less pronounced attrition and a shorter distance between alveolar and enamel margin.

12. Subjects with larger numbers of filling points have larger numbers of gingivitis points. Around teeth with fillings there were no

appreciable changes in the size of the pocket but the retraction of the gingiva was greater and the enamel margin — alveolar bone distance consistently greater than for intact teeth. All examinations concerned the younger group.

13. In the cases of crowding there was no appreciable change in the number of gingivitis points or of the depth of the pocket (younger group).

14. In the cases of diastema no appreciable change in the number of gingivitis points was to be seen.

15. Bad oral hygiene was accompanied by a greater number of gingivitis points, deeper pockets and greater alveolar bone-enamel margin distance than daily brushing were associated with. The investigation was performed on the older group.

16. In the older group the alveolar bone margin, the base of the pockets and the free gingival margin were on the average more apically situated than in the younger, this probably being an expression of continuous eruption.

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